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<b>(21) International Application Number:</b> PCT/GB99/01780 <b>(22) International Filing Date:</b> 4 June 1999 (04.06.99)		<b>(72) Inventor; and</b> <b>(75) Inventor/Applicant (for US only):</b> ROBERTS, Gareth, Wyn [GB/GB]; The Grange, Church Street, Great Shelford, Cambs. CB2 5EL (GB). <b>(74) Agent:</b> DAVIES, Jonathan, Mark; Reddie & Grose, 16 Theobalds Road, London WCLX 8PL (GB). <b>(81) Designated States:</b> AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>Without international search report and to be republished upon receipt of that report.</i>																																																	
<b>(30) Priority Data:</b> <table border="0"><tr><td>9812099.1</td><td>6 June 1998 (06.06.98)</td><td>GB</td></tr><tr><td>9813291.3</td><td>20 June 1998 (20.06.98)</td><td>GB</td></tr><tr><td>9813611.2</td><td>24 June 1998 (24.06.98)</td><td>GB</td></tr><tr><td>9813835.7</td><td>27 June 1998 (27.06.98)</td><td>GB</td></tr><tr><td>9814110.4</td><td>1 July 1998 (01.07.98)</td><td>GB</td></tr><tr><td>9814580.8</td><td>7 July 1998 (07.07.98)</td><td>GB</td></tr><tr><td>9815438.8</td><td>16 July 1998 (16.07.98)</td><td>GB</td></tr><tr><td>9815576.5</td><td>18 July 1998 (18.07.98)</td><td>GB</td></tr><tr><td>9815574.0</td><td>18 July 1998 (18.07.98)</td><td>GB</td></tr><tr><td>9816085.6</td><td>24 July 1998 (24.07.98)</td><td>GB</td></tr><tr><td>9816086.4</td><td>24 July 1998 (24.07.98)</td><td>GB</td></tr><tr><td>9816921.2</td><td>5 August 1998 (05.08.98)</td><td>GB</td></tr><tr><td>9817097.0</td><td>7 August 1998 (07.08.98)</td><td>GB</td></tr><tr><td>9817200.0</td><td>8 August 1998 (08.08.98)</td><td>GB</td></tr><tr><td>9817632.4</td><td>14 August 1998 (14.08.98)</td><td>GB</td></tr><tr><td>9817943.5</td><td>19 August 1998 (19.08.98)</td><td>GB</td></tr></table>		9812099.1	6 June 1998 (06.06.98)	GB	9813291.3	20 June 1998 (20.06.98)	GB	9813611.2	24 June 1998 (24.06.98)	GB	9813835.7	27 June 1998 (27.06.98)	GB	9814110.4	1 July 1998 (01.07.98)	GB	9814580.8	7 July 1998 (07.07.98)	GB	9815438.8	16 July 1998 (16.07.98)	GB	9815576.5	18 July 1998 (18.07.98)	GB	9815574.0	18 July 1998 (18.07.98)	GB	9816085.6	24 July 1998 (24.07.98)	GB	9816086.4	24 July 1998 (24.07.98)	GB	9816921.2	5 August 1998 (05.08.98)	GB	9817097.0	7 August 1998 (07.08.98)	GB	9817200.0	8 August 1998 (08.08.98)	GB	9817632.4	14 August 1998 (14.08.98)	GB	9817943.5	19 August 1998 (19.08.98)	GB		
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<b>(71) Applicant (for all designated States except US):</b> GENOSTIC PHARMA LIMITED [GB/GB]; Sycamore Studios, New road, Over, Cambridge CB4 5PJ (GB).																																																			
<b>(54) Title:</b> PROBES USED FOR GENETIC FILING																																																			
<b>(57) Abstract</b> <p>People vary enormously in their response to disease and also in their response to therapeutic interventions aimed at ameliorating the disease process and progression. However, the provision of medical care and medical management is centered around observations and protocols developed in clinical trials on groups or cohorts of patients. This group data is used to derive a standardised method of treatment which is subsequently applied on an individual basis. There is considerable evidence that a significant factor underlying the individual variability in response to disease, therapy and prognosis lies in a person's genetic make-up. There have been numerous examples relating that polymorphisms within a given gene can alter the functionality of the protein encoded by that gene thus leading to a variable physiological response. In order to bring about the integration of genomics into medical practice and enable design and building of a technology platform which will enable the everyday practice of molecular medicine a way must be invented for the DNA sequence data to be aligned with the identification of genes central to the induction, development, progression and outcome of disease or physiological states of interest. According to the invention, the number of genes and their configurations (mutations and polymorphisms) needed to be identified in order to provide critical clinical information concerning individual prognosis is considerably less than the 100,000 thought to comprise the human genome. The identification of the identity of the core group of genes enables the invention of a design for genetic profiling technologies which comprises of the identification of the core group of genes and their sequence variants required to provide a broad base of clinical prognostic information - 'genostics'. The "Genostic<sup>TM</sup>" profiling of patients and persons will radically enhance the ability of clinicians, healthcare professionals and other parties to plan and manage healthcare provision and the targeting of appropriate healthcare resources to those deemed most in need. The use of our invention could also lead to a host of new applications for such profiling technologies, such as identification of persons with particular work or environment related risk, selection of applicants for employment, training or specific opportunities or for the enhancing the planning and organisation of health services, education services and social services.</p>																																																			

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genes is strongly associated with lung cancer). The interaction of the relevant variant genes may be enough to cause a disease phenotype or spectrum of phenotypes, but in many cases other kinds of factors will also influence the course of events (e.g. interaction of ApoE genotype and head injury in Alzheimer's disease Nicholl et al 1996).

The identification of modifier genes that influence the penetrance and expressivity of these risk alleles will be key variables in assessing individual risk profiles. It is likely that the combination of and interaction between small discrete genetic influences on a disease state represent the single largest explanation for the phenotypic variation seen in medicine.

This opens the possibility that the identification of the genes associated with disease and an understanding of how these genes interact with the environment, can lead to better prediction of the outcome of both the disease and the therapeutic process. This in turn would allow the tailoring of resources and therapy to meet the likely requirements of the individual patient (Marshall 1997a). The net result should be improved clinical management, identification of the potential for prevention, the reduction of the burden of disability and, ultimately, improved quality of life for the individual (Poste 1998).

As a result of the appreciation of the contribution of genetic variation to medicine, considerable effort has been made to determine how individual genetic variations affect overall health (including predisposition to disease) and once disease is manifest, the likely patterns of progression, responsiveness to treatment and overall prognosis.

In a quest to understand and plot the limits of genetic variation in humans the Human Genome Project was launched in 1990 with a mission to sequence the code of all 100,000 or so human genes by 2002.

As a result of the Human Genome project not only is the mapping and sequencing of the human genome becoming well understood but also the degree of variability in gene sequence between individuals is being documented (Lander 1996). The average difference between individuals appears to be around 0.3% which equates roughly to a difference in one base pair every 500-1000 base pairs of sequence. The variations are known as polymorphisms and such polymorphic variation is thought underlie much of the clinical variability observed in patients with disease and in their response to therapy.

The resultant explosion of genetic sequence information has lead to the emerging sciences of genomics and proteomics. Within the disciplines technologies have evolved (e.g. polymerase chain reaction, single strand conformational polymorphism etc) which allow us to read individual sequence data and detect and identify polymorphic variation in individuals, in disease states and in different ethnic groups (Griffin et al 1997, Little et al 1997).

As a result of such studies individual genes have been identified which indicate a

predisposition to disease or a susceptibility to adverse drug responses (e.g. presenilin gene mutations and development of Alzheimer's disease, BRCA gene mutation and development of breast cancer, ACE polymorphisms and early onset heart disease, cytochrome P450 polymorphisms and drug metabolism).

However, such studies have been completed as academic exercises in scientific discovery and involve individual genes and large groups of patients.

Usually a particular individual response to disease or therapy is likely to result from a complex interaction between multiple genes, discrete environmental factors and the particular therapeutic approach offered (for example see algorithms in Figs. 1 and 2).

As a result, despite the many publications concerning the theoretical or potential applications of genomics to medicine (e.g. Marshall 1997a and b, Poste 1998, Crooke 1998), progress in implementing these approaches on a practical level has been exceedingly slow. In particular, little progress has been made in the understanding of or the ability to prognose individual response to particular disease states or therapeutic regimes (Poste 1998).

In part this has been related to the types of technology available for such studies (Marshall and Hodgson 1998). Such techniques as MALDI-TOF (Griffin et al 1997), sequencing (Dramanac et al 1998) and molecular beacons (Tyagi et al 1998) are complex and relatively slow and require the availability of specialised laboratories and highly trained personnel.

In recent reviews of the field it has been stated that:

- 'within next 10 years when not only all genes (will have been) identified but all common intragenic variation also' (Lander 1996).
- the 'assembly of comprehensive clinical databanks and their use for large-scale genetic association studies to define robust disease-gene risk correlations' constitutes a significant technological challenge (Poste 1998).
- 'if all human DNA variants were known this set would include all functional polymorphisms and if they could be analysed in all individuals comparison of phenotypes and correlation with genotype might make possible the assignment of function to every gene that predisposes to disease of any kind, and also to non-clinical phenotypes including behavioural traits. **The sheer task of this is overwhelming and may never be practical**' (Shafer and Hawkins 1998).

On the basis of the current state of the art it seems clear that translating the colossal investment in the human genome project into a means of revolutionising healthcare management requires both substantial creativity in the harnessing of technologies and considerable technical invention before its promise of can be realised.

For the realisation of the promised revolution in medicine two key factors require consideration;

- The human genome is made up of some 100,000 separate genes.
- Not all genes are of equal biological importance as regards the physiological functioning of humans.

The first issue, that of reading and tracking the volume of information encapsulated in the human genome by the sequence of 100,000 genes and their mutations and polymorphic variations, is beginning to be addressed by emergent technologies such as DNACHIPS, MALDI-TOF MS (Marshall and Hodgson 1998 see Table 1) and PEDIAT-type technologies (Fox 1998).

Table 1. The main features of some hybridization array formats currently available (Marshall &amp; Hodgson 1998)

Company	Arraying method	Hybridization step	Readout	Main focus
Affymetrix (Santa Clara, CA)	On-chip photolithographic synthesis of -20-25-mer oligos onto silicon wafers, which are diced in 1.24 cm <sup>2</sup> or 5.25 cm <sup>2</sup> chips	10,000-260,000 oligo features probed with labelled 30-40 nucleotide fragments of sample cDNA or antisense RNA	Fluorescence	Expression profiling, polymorphism analysis, and diagnosis
Brax (Cambridge, UK)	Short synthetic oligo, synthesized off chip	1,000 oligos on a "universal chip" probed with tagged nucleic acids	Mass spectrometry	Diagnostics, expression profiling, novel gene identification
Hyseq (Sunnyvale, CA)	500-2000 nt DNA samples printed onto 0.6 cm <sup>2</sup> (HyGnostics) or ~18 cm <sup>2</sup> (Gene Discovery) membranes	64 sample cDNA spots probed with 8,000 7-mer oligos (HyGnostics) or ≤55,000 sample cDNA spots probed with 300 7-mer oligos (Gene Discovery)	Radioisotope	Expression profiling, novel gene identification, and large-scale sequencing (Gene Discovery array), polymorphism analysis and diagnostics (HyGnostics/ HyChip arrays), and large-sample sequencing (HyChip array)
	Prefabricated 5-mer oligos printed as 1.15 cm <sup>2</sup> arrays onto glass (HyChip)	Universal 1024 oligo spots probed 10 kb sample cDNAs, labelled 5-mer oligos and ligase	Fluorescence	
Incyte Pharmaceuticals (Palo Alto, CA)	Piezoelectric printing for spotting PCR fragments and on-chip synthesis of oligos	≤ (eventually 10,000) oligo/PCR fragment spots probed with labelled RNA	Fluorescence and Radioisotope	Expression profiling Polymorphism analysis, Diagnostics
Molecular Dynamics (Sunnyvale, CA)	500-5000 nt cDNAs printed by pen onto ~10 cm <sup>2</sup> on glass slide	~10,000 cDNA spots probed with 200-400 nt labelled sample cDNAs	Fluorescence	Expression profiling and novel gene identification
Nanogen (San Diego, CA)	Prefabricated ~20 mer oligos, captured onto electroactive spots on silicon wafer, which are diced. Into ≤ 1 cm <sup>2</sup> chips	25, 64, 100, 400 (and eventually 10,000) oligo spots polarized to enhance hybridization to 200-400 nt labelled sample cDNAs	Fluorescence	Diagnostics and short tandem repeat identification
Protogene Laboratories (Palo Alto, CA)	On-chip synthesis of 40-50-mer oligos onto 9 cm <sup>2</sup> glass chip via printing to a surface-tension array	≤8,000 oligo spots probed with 200-400 nt labelled sample nucleic acids	Fluorescence	Expression profiling, and polymorphism analysis
Sequenom (Hamburg, Germany and San Diego, CA)	Off-set printing of array, around 20-25-mer	250 locations per SpectroChip interrogated by laser desorption and mass spectrometry	Mass spectrometry	Novel gene identification, candidate gene validation, diagnostics, and mapping
Synteni (Fremont, CA)	500-5000 nt cDNAs printed by tip onto ~4	≤10,000 cDNA spots probed with 200-400 nt labelled sample	Fluorescence	Expression profiling and novel gene identification

	cm <sup>2</sup> glass chip	cDNAs		
The German Cancer Institute (Heidelberg, Germany)	Prototypic DNA macrochip with on-chip synthesis of probes using f-moc or t-boc chemistry	Around 1000 spots on a 8x12 cm chip	Fluorescence/ mass spectrometry	Expression profiling and diagnostics

These new technologies mark a significant advance in the potential application of genomic information to the problems of biology and human health. The reason for this is their capability of determining or confirming a large volume of DNA sequence data very quickly at the individual level. In this way they open the door to the application of genomic information to the individual patient.

These technologies are also evolving quickly according to Moore's Law (which posits that computer chips' power doubles every 18 months). For instance, three years ago the genechips made by leading companies held some 20,000 DNA probes. Currently genechips with 65,000 probes are available, and a chip with 400,000 probes has recently been produced (Marshall and Hodgson 1998). Applications for such technologies have included sequencing, diagnostics (mutation detection in the BRCA1 gene for cancer), gene discovery, gene expression profiling and gene mapping (Marshall and Hodgson 1998).

However despite their value as research and diagnostic tools, the genechips in existence are utilized largely as research tools (Marshall and Hodgson 1998). They have not been used as a tool for the express purpose of improving healthcare management by enabling the process of clinical prognosis and facilitating the generation of health risk profiles.

The reason for this is the failure to conceive of or invent an appropriate design which identifies the critical core of genes which are the most important in terms of human function. The genetic variability in this group of genes is the most important contributor to the variation in clinical and physiological phenotypes. Not all genes are equally important in the normal physiological functioning of the human body nor in the induction, development or progression of diseases or physiological states. In a given disease, as few as 5-10 genes in different configurations may be of seminal importance in determining the vast bulk of inter-individual variability to disease and therapeutic approaches (Drews 1997, Goodman and Gillman 1996).

As such, a device capable of delivering information on 10,000 genes may leave its user in grave danger of information overload and render him/her unable to identify and abstract the critical information required to enhance patient management or healthcare.

As a result, the translation of such technologies in genechip devices from research tools into healthcare management tools is severely limited (Marshall and Hodgson 1998, Poste 1998, Schafer and Hawkins 1997).

In an effort to overcome this difficulty a consortium of academic and industrial groups

(SNP Consortium) has been formed to try and identify the important disease related variants of human genes. The technologies to be used are the generation and assembly of a SNP map spanning the whole human genome and its application to linkage studies.

However, this approach is still in its infancy and is widely held to face considerable technical hurdles in the robust statistical analysis of huge datasets.

In order to bring about the integration of genomics into medical practice and enable design and building of a technology platform which will enable the everyday practice of molecular medicine a way must be invented for the DNA sequence data to be aligned with the identification of genes central to the induction, development, progression and outcome of disease or physiological states of interest:

Practitioners of molecular healthcare need to be able to;

- Identify the presence or absence of a selected group of genes and polymorphic variants central to the induction, development progression and outcome of disease or physiological states
- Focus on polymorphisms that lie within the coding or regulatory regions of the gene and are likely to result in altered structure or expression of the protein.
- Utilise the data on the core group of genes in order to generate guidelines and guidance for the healthcare management of patients or persons.

The invention described herein identifies the core group of genes required for the design development and manufacture of such a valuable aid to clinical management of the patient and general healthcare management.

According to the invention, the number of genes and their configurations (mutations and polymorphisms) needed to be identified in order to provide critical clinical information concerning individual prognosis is considerably less than the 100,000 thought to comprise the human genome.

The identification of the identity of the core group of genes enables the invention of a design for genetic profiling technologies which comprises of the identification of the core group of genes and their sequence variants required to provide a broad base of clinical prognostic information - 'genostics'.

By careful and lengthy research of the literature, tabulation of data, cross referencing of studies and conduction of a variety of experiments we have identified the core group of genes, which, if assessed for the presence of their functional variants, will enable an enhanced prognosis for an individual patient and form the basis for converting genetic profiling technologies from research tools into universal tools for health management.

Identification of the core group of genes and their functional variants also allows for said technologies to be utilised in generating individual health-risk profiles and profiling the health-risks of the population at large. The determination and

identification of sequence data required to identify the important functional variants is readily accomplished by those skilled in the practice of the relevant arts.

The invention does not provide a method for treatment as such. Nor does it provide a direct method of diagnosis of illness or health risk as such. Information obtainable using the invention can be used by a medical practitioner to tailor resources and therapy to meet the likely requirements of individual patients and selected populations of patients. For example in a complex regime or clinical management plan (as seen for example in Fig. 1 and 2) the invention allows the better prediction of the outcome of both the disease and the chosen therapeutic process.

The enablement of the invention and the generation of the information required for the design of 'genostics' requires:

1. Identification of sequence data (Example 1).
2. Assessment of the type and significance of sequence variation in the core group of genes (Examples 2,3,4).
3. Identification of likely genetic variation/disease relationships (Example 5 and 5a).
4. Means of identifying and detecting additional polymorphisms in the core group of genes (Example 6).
5. A practical approach to data analysis to generate information on prognosis(Example 7).
6. An illustration of how clinical management of a patient can be enhanced by utilising genetic profiling approaches (Example 8 and 9).

#### EXAMPLE 1

Gene sequence data is readily available in the public domain.

For the design of the GENOSTIC genechip device, gene sequence data can be retrieved, by persons skilled in the art, by searching the following public databases:

Website	Address	Description
DbEST	<a href="http://www.ncbi.nlm.nih.gov/dbEST">http://www.ncbi.nlm.nih.gov/dbEST</a>	Database of expressed sequence tags
EBI/EMBL	<a href="http://www.ebi.ac.uk/mutations/">http://www.ebi.ac.uk/mutations/</a>	Mutations
EBI: The European Bioinformatics Institute, Hinxton, UK	<a href="http://www.ebi.ac.uk/ebi_home.html">http://www.ebi.ac.uk/ebi_home.html</a>	Nucleotide Sequence Database
EMBL	<a href="http://www.ebi.ac.uk/queries/queries.html">http://www.ebi.ac.uk/queries/queries.html</a>	Nucleotide Sequence Database
GDB: The Genome Database, Infobiogen European Node, FRANCE	<a href="http://www.gdb.org/gdb/gdbtop.html">http://www.gdb.org/gdb/gdbtop.html</a>	Human Genome Database

<b>GeneCards</b>	<a href="http://bioinformatics.weizmann.ac.il/cards/index.html">http://bioinformatics.weizmann.ac.il/cards/index.html</a>	<b>GeneCards</b> is a database of human genes, their products and their involvement in diseases.
<b>GeneClinics</b>	<a href="http://www.geneclinics.org/">http://www.geneclinics.org/</a>	<i>GeneClinics (formerly Genline)</i> is a knowledge base of expert-authored, up-to-date information relating genetic testing to the diagnosis, management, and counseling of individuals and families with inherited disorders.
<b>Genethon</b>	<a href="http://www.genethon.fr/genethon_en.html">http://www.genethon.fr/genethon_en.html</a>	The Human Genome Research Centre.
<b>GSDB: Genome Sequence database</b>	<a href="http://www.ncgr.org/">http://www.ncgr.org/</a>	A collection of DNA sequence data and related information.
<b>HGP: Human Genome Project Information</b>	<a href="http://www.ornl.gov/TechResources/Human_Genome/home.html">http://www.ornl.gov/TechResources/Human_Genome/home.html</a>	Useful background & links.
<b>Human Gene Mutation Database</b>	<a href="http://www.uwcm.ac.uk/uwcm/mg/search">http://www.uwcm.ac.uk/uwcm/mg/search</a>	Mutations
<b>NCBI</b>	<a href="http://www.ncbi.nlm.nih.gov/">http://www.ncbi.nlm.nih.gov/</a>	KEY SITE. Nucleotide Sequence retrieval start point.
<b>OMIM: Online Mendelian Inheritance in Man</b>	<a href="http://www.ncbi.nlm.nih.gov/Omim/">http://www.ncbi.nlm.nih.gov/Omim/</a>	This database is a catalog of human genes and genetic disorders.
<b>PubMed</b>	<a href="http://www.ncbi.nlm.nih.gov/PubMed/">http://www.ncbi.nlm.nih.gov/PubMed/</a>	PubMed accesses MEDLINE medical literature database and links to full-text journals. It is also the literature component of the Entrez retrieval system for molecular biology information.
<b>Research Tools (Science - NCBI)</b>	<a href="http://www.ncbi.nlm.nih.gov/SCIENCE96/ResTools.html">http://www.ncbi.nlm.nih.gov/SCIENCE96/ResTools.html</a>	A Gene Map of the Human Genome.
<b>RHdb: Radiation Hybrid Database, Hinxton, UK</b>	<a href="http://www.ebi.ac.uk/RHdb">http://www.ebi.ac.uk/RHdb</a>	Radiation Hybrid Database.
<b>Stanford Human Genome Centre</b>	<a href="http://www.shgc.stanford.edu/">http://www.shgc.stanford.edu/</a>	Sequence database.
<b>HUGO: The Human Genome Organisation</b>	<a href="http://www.gene.ucl.ac.uk/hugo">http://www.gene.ucl.ac.uk/hugo</a>	HUGO is the international organisation of scientists involved in the Human Genome Project.
<b>TIGR: The Institute for Genomic Research</b>	<a href="http://www.tigr.org/">http://www.tigr.org/</a>	Genomic databases.
<b>The National Human Genome Research Institute</b>	<a href="http://www.nhgri.nih.gov/">http://www.nhgri.nih.gov/</a>	Access to sequence databases



The Whitehead Institute Center for Genome Research	<a href="http://www.genome.wi.mit.edu/">http://www.genome.wi.mit.edu/</a>	Genome map and sequence information.
Unigene: Unique Human Gene Sequence Collection. (NCBI)	<a href="http://www.ncbi.nlm.nih.gov/UniGene/index.html">http://www.ncbi.nlm.nih.gov/UniGene/index.html</a>	UniGene is a system for automatically partitioning GenBank sequences into a non-redundant set of gene- oriented clusters. Each UniGene cluster contains sequences that represent a unique gene, as well as related information such as the tissue types in which the gene has been expressed and map location.
University of Oklahoma	<a href="http://dna1.chem.ou.edu/index.html">http://dna1.chem.ou.edu/index.html</a>	Genomic databases
WEHI, Melbourne, Aus	<a href="http://wehih.wehi.edu.au/srs/srsc/">http://wehih.wehi.edu.au/srs/srsc/</a>	Sequence Retrieval System

Genes coding for proteins known to play a key role in organ function or disease are designated 'candidate genostic genes'. Variations within the gene structure may alter the regulatory or structural integrity of the gene product leading to enhancement or reduction in the specific function (e.g. receptor binding, enzyme activity). The exact role that a candidate gene plays in disease, prognosis and healthcare management can be fully ascertained by assessing the effects of variation in gene structure in particular patient groups, populations or individuals (see examples 2,3 and 4).

## **EXAMPLE 2 -Candidate Genostic Genes**

### **Human Neuronal Nitric Oxide Synthetase**

Gene Map Locus: 12q24.2q24.31(OMIM Ref. 163731).

One candidate 'genostic' gene is the gene encoding nitric oxide synthetase (NOS-1).

The enzymes responsible for NO synthesis in man constitute a family with at least three distinct isoforms: inducible, endothelial, and neuronal. Neuronal NO synthetase (NOS-1) is localised to human chromosome 12, and participates in diverse biologic processes including neurotransmission, the regulation of body fluid homeostasis, neuroendocrine physiology, control of smooth muscle motility, sexual function and monocyte biology.

Burnett et al. (1992) localized NO synthase to rat penile neurons innervating the corpora cavernosa and to neuronal plexuses in the adventitial layer of penile arteries. They demonstrated that small doses of NO synthase inhibitors abolished electrophysiologically induced penile erections establishing that nitric oxide is a physiologic mediator of erectile function.

Kharazia et al. (1994) found that all neurons in the striatum and many in the cortex were positive for nitric oxide synthase indicating a role of NOS in brain function.

NOS1 cDNA clones contain different 5-prime terminal exons spliced to a common exon 2. Xie et al. (1995) demonstrated that the unique exons are positioned within 300 bp of each other but separated from exon 2 by an intron that is at least 20 kb long. A CpG island engulfs the downstream 5-prime terminal exon. In contrast, most of the upstream exon resides outside of this CpG island. The upstream exon includes a GT dinucleotide repeat. The expression of these 2 exons is subject to transcriptional control by separate promoters. Nitric oxide is synthesized in skeletal muscle by neuronal-type NO synthase, which is localized to sarcolemma of fast-twitch fibers. Synthesis of NO in active muscle opposes contractile force. Brenman et al. (1995) showed that NOS1 partitions with skeletal muscle membranes owing to association of enzyme with dystrophin, the protein mutated in Duchenne muscular dystrophy. The dystrophin complex interacts with an N-terminal domain of NOS1 that contains a GLGF motif. Both humans with DMD and mdx mice show a selective loss of NOS1 protein and catalytic activity from muscle membranes. NOS1-deficient mice are resistant to neural stroke damage following middle cerebral artery ligation. Nelson et al. (1995) reported a large increase in aggressive behavior and excess, inappropriate sexual behavior in NOS1 'knockout' mice. Initial observations indicated that male (but not female) NOS1-deficient mice engaged in chronic aggressive behavior.

Magee et al. (1996) used PCR to clone a novel form of neuronal NOS from rat penile RNA. This NOS cDNA was termed PnNOS for 'penile neuronal NOS.' Sequencing revealed that the PnNOS cDNA was identical to rat cerebellar neuronal NOS1 except for a 102-bp insertion in PnNOS. Repetition of RT-PCR showed PnNOS to be the only form of NOS1 expressed in rat penis, urethra, prostate, and skeletal muscle. PnNOS may be responsible for the synthesis of nitric oxide during penile erection and may be involved in control of the tone of the urethra, prostate, and bladder.

Using the available genomic sequence of neuronal NOS-1 it is possible to identify those parts of the gene which show variation sufficient to alter the normal functioning of the gene.

1.) Transcriptional Promoter Sequences:

Sequence mutations in the promoter region of the NOS1 gene will allow the identification of individuals with altered transcriptional regulation control.

2.) RNA Processing (Splicing) Sequences:

Characterise mutations in the intron/exon structure of the NOS1 gene to identify individuals with altered RNA splicing patterns. These results in truncated proteins or splice variants with an altered function.

3.) Messenger RNA Translation and Stability Sequences:

Sequence and characterise mutations within the repetitive sequences located in the 3' untranslated region of the NOS-1 gene. These individuals have altered translational control of their mRNA.

4.) DNA Sequences Involved in Genomic Rearrangement or Expansion:

The presence of Alu-1 repeat, which are known to cause recombination, allows one to detect gross chromosomal rearrangements. Changes in either the sequence or the genomic structure may well correlate with clinical or pathological symptoms.

102-bp insertion will also be involved in the functional variation of activity involving the urogenital tract.

5.) Coding Sequences:

Mutations and polymorphisms in the coding (exon) sequences of the NOS-1 gene will result in changes at the structural level of the protein with functional changes. Amino acid substitutions, within neuronal NOS-1, will play a role in age/brain related neuronal defects.

The specific sequences are detailed in Table 2.

**TABLE 2: Summary of Genome Elements within the Neuronal Nitric Oxide Synthetase Gene.**

Gene Anatomy	Key Region	Functional Elements
1. 5' Flanking Region:	GC-enriched sequences:	DNA methyltransferase foot print region CpG Island
	Promoter elements	TATA box Inverted CAAT boxes AP-2-like element CREB/ATF element c-Fos element NF-kB-like ETS-binding sites TEF-1/MCBF binding sites NRF-1 binding sites RNA Pol III site
2. Exon Coding Regions		Translation initiation exon 2 Translation termination exon 29
3. RNA Processing		Intron/exon boundaries (1-29) Cassette splicing exons 9-11
4. RNA Translation		3' Untranslated Region
5. Insertion		102bp insertion
6.Repetitive Sequences		Alu-1 family Dinucleotide repeats

These variations in the genomic structure of the human NOS 1 gene are important in controlling the physiological role of NOS in normal or disease states in humans. Alterations in the physiology of NOS have significant healthcare indications (i.e stroke, cardiac and circulatory disease, urogenital disease and dysfunction, psychiatric symptoms and musculoskeletal disorders).

In consideration with an assessment of the functional variation in other genes, identification of the pattern of NOS 1 gene variation in a patient cohort, population or individual offers a powerful practical tool for improving the management of healthcare and the prognosis of health risk.

### EXAMPLE 3

#### **Voltage-gated calcium channels**

Gene map locus (OMIM Ref.601011)

Other candidate 'genostic' genes are the calcium channel subunit genes.

There are six functional subclasses of calcium channel. Voltage-dependent Ca(2+)

channels not only mediate the entry of  $\text{Ca}(2+)$  ions into excitable cells but are also involved in a variety of  $\text{Ca}(2+)$  – dependant processes, including muscle contraction, hormone or neurotransmitter release and gene expression.

Calcium Channels are multi-subunit complexes and the channel activity is directed by a pore-forming  $\alpha$ -1 sub-unit. The auxillary sub-units  $\beta$ ,  $\alpha$ -2/ $\delta$ , and  $\gamma$  regulate channel activity.  $\text{Ca}(2+)$  currents have been described on the basis of their biophysical and pharmacological properties and include L-, N-, T-, P-, Q-, and R- types.

P/Q type channels colocalise with a subset of docked vesicles at the synapse where they control exocytosis, demonstrated by the sensitivity of various types of neurotransmission to specific blockers of these channels. P/Q type channels are involved in CSD (cortical spreading depression – which causes the aura or visual symptoms of migraine) and release of neurotransmitters, including 5-HT (migraine patients have systemic disturbance of 5-HT metabolism).

The distinctive properties of each of the  $\text{Ca}(2+)$  channel types are primarily related to the expression of a variety of  $\alpha$ -1 isoforms (Dunlap *et al.*, 1995). There are at least 6 classes of  $\alpha$ -1 subunits:  $\alpha$ -1A, B, C, D, E and S. They are derived from 6 genes representing members of a gene family. The  $\alpha$ -1A, B and E isoforms are abundantly expressed in the neuronal tissue. The genes encoding the  $\alpha$ -1A, B, and E isoforms are symbolised CACNL1A4, CACNL1A5, and CACNL1A6 respectively.

The CACNL1A4 gene was assigned to 19p13, (Diriong *et al.*, 1995). The gene was characterised by Ophoff *et al.* (1996) in preparation for a mutation search in neurological disorders that map to 19p13. They found that the gene covers 300 kb with 47 exons and reported the amino acid sequence for residues 1-2262. Sequencing of all the exons and their surroundings revealed polymorphic variations, including a (CA) $n$ -repeat, a (CAG) $n$ -repeat in the 3-prime-UTR, and different types of deleterious mutations in 2 neurological disorders; familial hemiplegic migraine and episodic ataxia type 2. Thus, these 2 neurological disorders are allelic channelopathies.

Calcium channels are also known to be important in regulating the function of the heart (particularly arrhythmias) and a number of drugs express their therapeutic effects by blocking myocardial  $\text{Ca}(2+)$  or prolonging the activation time of the channel (Brody, Larner and Minneman 1998). Polymorphic variation can help predict individual response to injury and disease, the symptoms and consequences of cardiovascular disease, dysfunction and damage to the system.

## EXAMPLE 4

### Lipoprotein lipase LPL

Gene map locus (OMIN Ref.238600)

A third example of a candidate for a 'genostic' gene is the enzyme lipoprotein lipase (LPL).

Human lipoprotein lipase is a member of a lipase gene family, which also includes the hepatic and pancreatic lipases. LPL is located on the surface of endothelial cells of capillaries where it hydrolyses triacylglycerols of plasma lipoproteins to fatty acids and glycerol. These fatty acids are then taken up by cell and used for energy production. The enzyme plays a central role in lipid metabolism and is a candidate susceptibility gene for cardiovascular disease.

The LPL gene contains ten exons spanning 30kb and encodes a protein of 475 amino acids and has several well characterised functional domains including the APOC-II binding site, the heparin-binding clusters used to localise LPL to the endothelial wall and the domains that contribute to the active site.

Diseases that affect the metabolism and transport of lipids frequently result in abnormally high plasma triacylglycerols and or cholesterol that are often associated with coronary artery disease, atherosclerosis and/or obesity. DNA sequence variation in genes that encode many of the enzymes and proteins involved in lipid metabolism and transport (including LPL) have been identified and associated with clinically abnormal lipid profiles.

The LPL gene sequence has been shown to contain distinct sequence variations among populations, (Nickerson *et al*, 1998). Nickerson *et al* described 88 variants in a region of the LPL gene, 90% of which were single nucleotide polymorphisms (SNPs), the remaining being insertion-deletion variations. 81 variants were found in intronic regions, and 7 in the exonic sequence. Only 4 of the exonic variants altered the protein sequence.

Assessing the functional variability of the LPL gene in conjunction with the functional variability of other core genes will provide a tool in predicting the likelihood of developing a range of diseases including the symptoms and consequences of coronary artery disease, atherosclerosis and/or obesity.

As shown above, sequence data for genes of interest can be readily obtained. Genetic variation in specific regions of genes can also be determined. The identification of a core group of genes which have important effects on the key physiological and pathophysiological processes in human disease would form an important medical advance.

A device or detector configured and designed using this core group of genes (GENOSTIC) would have a general utility in the practice of medicine and healthcare management for:

- prognosing the course of illness
- predicting likely therapeutic response
- identifying potential adverse event profile.

## EXAMPLE 5

**LIST OF GENES WITH KNOWN ASSOCIATION WITH DISEASE**

The following are examples of genes with known associations with disease which can be discerned by a careful review of the medical and biochemical literature and by experimentation. Many such genes can also be identified by a review of publicly available databases e.g. Human Gene Mutation Database (<http://www.uwcm.ac.uk/uwcm/mg/search/>), OMIM Database (<http://www.ncbi.nlm.nih.gov/omim>) or GENECARDS (<http://bioinformatics.weizmann.ac.il/cards/index.html>).

Note: The tabulated genes are listed in alphabetical groups, but the numbering of genes within each group is not necessarily continuous.

A	B	C	D
1: APOA4	1: BLM	1: CRYAA	1: DPYD
2: AAC2	2: BCKDHA	2: CRYBB2	2: DIAPH1
3: AD2	3: BTD	3: CHM	3: DMD
4: AGA	4: BPGM	4: C2	4: DPYS
5: APOA1	5: BRCA2	5: C5	5: DFN1
6: ALAS2	6: BRCA1	6: C9	6: DKC1
7: ALB	7: BCP	7: C3	7: DLD
8: APT1	8: BLMH	8: C7	8: DFNA5
9: APOA2	9: BCKDHB	9: CTNS	9: DTD
10: APOH	10: BCHE	10: C1QA	10: DCX
11: AMELX	12: BTK	11: C1QB	11: DYT1
12: APT1LG1	13: BARD1	12: CNGA3	12: DMPK
13: A2M	18: BSEP	13: C1QG	13: DRD4
14: APBB1		14: CPO	14: DDB2
15: AGXT		15: CDH1	15: DIAPH2
16: AGTR1		16: C4A	16: dgcr5
17: ALDH2		17: C4B	17: DRD2
18: ARG1		18: C6	18: DES
19: ALD		19: C8B	19: DBT
20: AGT		20: CACT	20: DCP1
21: ACHE		21: chit	24: DYSF
22: ADSL		22: CLCN1	27: DRA
23: ADRB3		23: CFTR	29: DLX3
24: atpsk2		24: COL10A1	31: DRPLA
25: ATM		25: CYP1A1	38: DIA1
26: ASPA		26: CLCNKB	39: DHAPAT
27: ACTC		27: CD3G	
28: ADRB2		28: CACNA1F	
29: AIRE		29: CPS1	
30: AZF1		30: CRX	
31: AT3		31: CYBA	
32: ABO		32: CKN1	
33: ABCR		33: CST3	
34: AACT		34: CNGA1	
36: ANK1		35: CETP	
37: ALAD		36: CAT	
38: APOE		37: CTSK	
39: APP		38: CYBB	
40: APOC3		40: CSX	



E	F	G	H
1: EPOR	1: FUCA1	1: GM2A	2: HD
2: EPB41	2: FRDA	2: GYPC	3: HK1
3: EMX2	3: FGB	3: GALT	5: HBG2
4: EXT2	4: FH	4: GLB1	6: HSD3B2
5: EMD	5: FGG	5: GALE	7: HBG1
6: ED1	6: FMR2	6: GAMT	9: HFE
7: ESR	7: FGFR1	7: GYPA	10: HTN3
8: EXT1	8: FGA	8: GPI	11: HOXA13
9: EPHX1	9: F10	9: GPC3	12: HR
10: EPX-PEN	10: FUT6	10: GLI3	13: HBA1
11: EDNRB	11: FKHL15	11: GCDH	14: HMGCL
12: EPM2A	12: FRAXF	12: GAA	15: HBD
13: EDN3	13: FBP1	13: G6PC	16: HTR2C
14: ETFA	14: F11	14: GBA	18: HP
15: ETFB	15: F12	15: GALK1	19: HSD11B2
16: ENG	16: FCGR1A	16: GBE1	20: HK2
17: EPB42	17: FBN2	17: GLS	21: HPS
18: ETFDH	18: FAH	18: G6PT1	23: HGD
19: EFE2	19: FSHR	19: GLUD1	25: HBA2
20: ERCC5	20: F13B	20: GRL	26: HCF2
22: ERCC4	21: FMO3	21: GSS	27: HRG
23: ELN	22: FUT3	22: GK	28: HOXD13
24: EYA1	23: F13A1	23: GP1BB	29: HEXB
25: ERCC6	24: FANCA	24: GSN	32: HLCS
26: ERCC3	25: F7	25: GCGR	33: HPRT1
27: EGR2	26: FTL	26: GLRA1	34: HBB
28: ERCC2	27: F5	27: GH1	35: HTR1A
	28: FUT2	28: G6PD	36: HSD17B1
	29: FMR1	29: GYS2	37: HSD17B3
	30: FCMD	30: GHRHR	40: HSD17B4
	31: FGDY	31: GH2	
	32: FANCC	32: GCP	
	33: FCGR2A	33: GALT	
	34: FGFR3	34: GP9	
	35: FECH	35: GNRHR	
	36: FSHB	36: GIPR	
	37: F8C	37: GSTT1	
	38: FBN1	38: GLA	
	39: FABP2	39: GRPR	
	40: F9	40: GPD2	

I	J	K	L
1: IL2RA	1: JAG1	1: KRT9	1: LPL
2: IVD	2: JAK3	2: KCNQ3	2: LIPC
4: IFNGR1		3: KRT1	3: LOR
5: IL2RG		4: KNG	4: LDLR
6: IFNGR2		5: KRT16	5: LYZ
7: IGHG2		6: KRT18	6: LIG1
9: INSR		7: KRT6A	7: LDHA
10: IDUA		8: KRT6B	8: LDHB
11: IL4R		9: KRT3	9: LQT2
12: ITGA7		10: KHK	10: LEPR
13: ITGA2B		11: KRTHB1	11: LHCGR
14: IGKV		12: KEL	12: LEP
15: IAPP		13: KRTHB6	13: LHB
16: IPF1		14: KAL1	14: LIPA
17: INS		15: KRT4	15: LAMA3
18: IGF1		16: KRT13	16: LICAM
19: IGHM		17: KRT2A	17: LAMC2
20: ITGA6		18: KRT12	19: LCAT
21: IRS1		19: KRT5	20: LAMA2
22: ICAM1		20: KRT14	21: LMX1B
23: ITGB3		21: KRT10	22: LTBP2
24: ITGB4		22: KRT17	23: LMAN1
25: IDS		23: KCNQ2	26: LAMB3
28: ITGB2		24: KCNQ1	
		26: KCNJ1	
		28: KCNJ11	
		30: KCNA1	
		32: KIT	
		36: KCNE1	

M	N	O	P
1: MTM1	1: NME1	1: OA1	1: PROP1
2: MUT	2: NF1	2: OCA2	2: PLP
3: MTR	3: NBS1	3: OCRL	3: PRPS1
4: MLH1	4: NPHP1	4: OXCT	4: PEPD
5: MMP3	5: NF2	5: OPHN1	5: PCCB
6: MVK	6: NCF1	6: OTC	6: PCCA
7: MANBA	7: NDP	7: OAT	7: PCSK1
8: MTRR	8: NCF2	8: COL1A2	8: PAH
9: MANB	9: NP		9: POU1F1
10: MPO	10: NEU		10: PPOX
11: MYO5A	11: NTF3		11: PRKCG
12: MYH7	12: NOTCH3		12: PXMP1
13: MAOA	13: NRTN		13: PPGB
14: MYOC	14: CHRNA4		14: PRB3
15: MADH4	15: NPC1		15: PRB1
16: MEFV	16: NAGA		16: PRB4
17: MAT1A	17: NEFH		17: PMP22
18: MEN1	18: NTRK1		18: PABP2
19: MOCS1	19: NAIP		19: PEX7
20: mocs1b	20: NDUFS4		20: PDDR
21: MLR	21: NOS3		21: PAFAH2
22: MSH2	23: NODAL		22: PARK2
23: MSX2	25: NAGLU		23: PLG
25: MPI			24: PPARG
26: MC4R			25: PON2
28: MDCR			26: PROC
29: MBL			27: PROS1
30: MJD			28: PDE6A
31: MC2R			29: PXMP3
32: MYL2			30: PPP1R3
33: MC1R			31: PON1
34: MYO15			32: PEX1
35: MAPT			33: PC
36: MPZ			34: PENK
37: MID1			35: PXR1
38: MSX1			36: PGK1
39: MGAT2			37: PTH
40: MTHFR			38: PDE6B
			39: PSEN2
			40: PKD2

Q	R	S	T
1: QDPR	1: RHO	1: SSA1	1: TAT
	2: RP2	2: SOD1	2: THBD
	3: RLBP1	3: COL2A1	3: TNNT2
	4: RHD	4: SDH2	4: TF
	5: RB1	5: SGSH	5: TBG
	6: ROM1	6: SLC5A5	6: TSC1
	7: RP3	7: SLC12A3	7: TCN2
	8: RHCE	8: SDH1	8: TPI1
	9: RHAG	9: SUOX	9: TPM1
	10: RHOK	10: STS	10: TBXA2R
	12: rfxank	11: ssadh	11: TPMT
	13: REN	12: SALL1	12: TYR
	14: RYR1	13: SHOX	13: TGM1
	15: RS1	14: SLC12A1	14: TTR
	16: RDS	15: SLC2A2	15: TSC2
	17: RFC2	16: SNRPN	16: TG
	18: RCP	17: SPTB	17: TTPA
	21: RFXAP	18: SCA2	18: TCOF1
	22: RAG2	19: SMN1	19: TULP1
	23: RPS6KA3	20: STK11	20: TNF
	24: RPE65	21: SPTA1	21: THPO
	25: RFX5	23: SH2D1A	22: TCF2
	26: RAG1	24: SCNN1B	23: TPO
		25: SI	24: TEK
		26: SCA1	25: TPM3
		27: SLC2A1	26: TYRP1
		28: SELE	27: TGFB1
		31: SAA1	28: TSHB
		32: SNCA	29: TNNT3
		33: SOD3	30: TIMP3
		34: SCN1B	31: TECTA
		35: SLC6A4	32: TAP1
		36: SRK	33: TCF14
		37: SLC5A1	36: TH
		39: SLC10A2	37: TSHR
			38: THRB
			39: TAP2
			40: TGFB2

U	V	W	X
1: UMPS	1: VWF	1: WT1	1: XPA
2: UGB	2: VDR	2: WFS1	2: XDH
3: USH2A	3: VMD2	3: WRN	3: XPC
4: UFD1L	4: VHL	4: WAS	6: XK
5: ugt1d			8: XIST
6: UROD			9: XRCC9
7: UBE3A			
8: UCP3			
9: UROS			
10: UGT1			
Y	Z		
	1: ZIC2		
	2: ZIC3		

**EXAMPLE 5a****POLYMORPHIC VARIATION**

For each gene, sequence data concerning the existence of polymorphic variation can be located. For example, below are the details of the polymorphic variations of six genes, representative of major gene product/protein categories on the core list.

**Category 1 - Enzymes** **$\alpha$ -glucosidase**

Mutation type	Total number of mutations
Nucleotide substitutions (missense / nonsense)	20
Nucleotide substitutions (splicing)	4
Nucleotide substitutions (regulatory)	0
Small deletions	7
Small insertions	0
Small indels	0
Gross deletions	1
Gross insertions & duplications	0
Complex rearrangements (including inversions)	1
Repeat variations	0
<b>TOTAL</b>	<b>33</b>

Accession Number	Codon	Nucleotide	Amino acid	Phenotype
CM970540	40	cCGA-TGA	Arg-Term	Glycogen storage disease 2
CM950491	299	CTG-CGG	Leu-Arg	Glycogen storage disease 2
CM980577	309	cGGG-AGG	Gly-Arg	Glycogen storage disease 2
CM910167	318	ATG-ACG	Met-Thr	Glycogen storage disease 2
CM900102	402	aTGG-CGG	Trp-Arg	Glycogen storage disease 2
CM940798	519	cATG-GTG	Met-Val	Glycogen storage disease 2

CM910168	521	cGAG-AAG	Glu-Lys	Glycogen storage disease 2
CM940799	545	CCT-CTT	Pro-Leu	Glycogen storage disease 2
CM980578	566	cTCC-CCC	Ser-Pro	Glycogen storage disease 2
CM930287	643	cGGG-AGG	Gly-Arg	Glycogen storage disease 2
CM940800	645	GACg-GAA	Asp-Glu	Glycogen storage disease 2
CM980579	645	cGAC-AAC	Asp-Asn	Glycogen storage disease 2
CM950492	645	cGAC-CAC	Asp-His	Glycogen storage disease 2
CM940801	647	TGCg-TGG	Cys-Trp	Glycogen storage disease 2
CM980580	648	cGGC-AGC	Gly-Ser	Glycogen storage disease 2
CM980581	672	CGG-CAG	Arg-Gln	Glycogen storage disease 2
CM980582	672	gCGG-TGG	Arg-Trp	Glycogen storage disease 2
CM930288	725	cCGG-TGG	Arg-Trp	Glycogen storage disease 2
CM980583	768	CCC-CGC	Pro-Arg	Glycogen storage disease 2
CM930289	854	cCGA-TGA	Arg-Term	Glycogen storage disease 2

Accession Number	IVS	Donor/ Acceptor	Relative location	Substitution	Phenotype
CS941486	1	as	-13	T-G	Glycogen storage disease 2
CS971665	6	as	-22	T-G	Glycogen storage disease 2
CS941487	10	ds	+1	G-C	Glycogen storage disease 2
CS971666	16	ds	+2	T-C	Glycogen storage disease 2

Accession Number	Location/ codon	Deletion	Phenotype
CD981927	126	GCAGCCC^TGGtgCTTCTTCCCA	Glycogen storage disease 2
CD972136	160	CACCTTC^TTCccCAAGGACATC	Glycogen storage disease 2
CD941678	174	TGATG^GAGACiGAGAACCGCC	Glycogen storage disease 2
CD961963	470	CATCACC^AACgagaCCGGCCAGCC	Glycogen storage disease 2
CD941679	485	CGGGTCC^ACTgccttccccgactTCACCAACCC	Glycogen storage disease 2
CD981928	674	CGGAAC^CACAacaGCCTGCTCAG	Glycogen storage disease 2
CD951684	902	GCAGCTG^CAGaagGTGACTGTCC	Glycogen storage disease 2

Description	Phenotype
536 bp I17E18-332 to E18I19+39 (mutation described at genomic DNA level)	Glycogen storage disease 2

Description	Phenotype
Ins C nt. 2741, ins G nt. 2743	Glycogen storage disease 2

## Category 2 - Transport and Storage

### Albumin

Mutation type	Total number of mutations
Nucleotide substitutions (missense / nonsense)	21
Nucleotide substitutions (splicing)	2
Nucleotide substitutions (regulatory)	0
Small deletions	2
Small insertions	1
Small indels	0
Gross deletions	0
Gross insertions & duplications	0
Complex rearrangements (including inversions)	0
Repeat variations	0
TOTAL	26

Accession Number	Codon	Nucleotide	Amino acid	Phenotype
CM910024	1	GAT-GTT	Asp-Val	Albumin variant
CM940018	3	aCAC-TAC	His-Tyr	Albumin variant
CM910025	-1	CGA-CAA	Arg-Gln	Albumin variant
CM910026	-2	CGT-CAT	Arg-His	Albumin variant
CM900011	-2	tCGT-TGT	Arg-Cys	Albumin variant
CM940019	32	tCAG-TAG	Gln-Term	Analbuminaemia
CM940020	114	cCGA-TGA	Arg-Term	Analbuminaemia
CM910027	128	CAT-CGT	His-Arg	Albumin variant
CM940021	214	TGGg-TGA	Trp-Term	Analbuminaemia
CM920015	218	CGC-CAC	Arg-His	Albumin variant
CM970070	218	CGC-CCC	Arg-Pro	Dysalbuminaemic hyperthyroxinaemia, familial
CM940022	225	cAAA-CAA	Lys-Gln	Albumin variant
CM940023	276	AAGg-AAC	Lys-Asn	Albumin variant
CM940024	313	AAGg-AAT	Lys-Asn	Albumin variant
CM910028	365	GAT-GTT	Asp-Val	Albumin variant
CM910029	372	cAAA-GAA	Lys-Glu	Albumin variant
CM900012	501	aGAG-AAG	Glu-Lys	Albumin variant
CM930016	505	tGAA-AAA	Glu-Lys	Albumin variant
CM940025	563	cGAT-AAT	Asp-Asn	Albumin variant
CM910030	570	cGAG-AAG	Glu-Lys	Albumin variant
CM940026	573	tAAA-GAA	Lys-Glu	Albumin variant

Accession Number	Location/codon	Deletion	Phenotype
CD941562	566	TAAGGAG^ACCtGCTTTGCCGA	Albumin variant
CD910474	579	TGCTGCA^AGTcAAGCTGCCTT	Analbuminaemia

Accession Number	Nucleotide	Codon	Insertion	Phenotype
CI941818	9156	267	A	Analbuminaemia

### Category 3 - Structural Proteins

#### Collagen IV alpha 3

Mutation type	Total number of mutations
Nucleotide substitutions (missense / nonsense)	2
Nucleotide substitutions (splicing)	1
Nucleotide substitutions (regulatory)	0
Small deletions	2
Small insertions	0
Small indels	0
Gross deletions	0
Gross insertions & duplications	0
Complex rearrangements (including inversions)	0
Repeat variations	0
TOTAL	5

Accession      Codon      Nucleotide      Amino acid      Phenotype

Number				
CM940306	1481	aCGA-TGA	Arg-Term	Alport syndrome
CM940307	1524	TCA-TGA	Ser-Term	Alport syndrome

Accession Number	IVS	Donor/Acceptor	Relative location	Substitution	Phenotype
CS951356	5	as	-320	G-T	Alport syndrome

Accession Number	Location/codon	Deletion	Phenotype
CD951631	1448	TTTGTC^TTCAcccgcacaCAGTCAAACC	Alport syndrome
CD941648	1471	AGTGGGT^TTTctttCTTTTGTAC	Alport syndrome

## Category 4 - Immune Protection and inflammation

### Interleukin 4 receptor

Mutation type	Total number of mutations
Nucleotide substitutions (missense / nonsense)	1
Nucleotide substitutions (splicing)	0
Nucleotide substitutions (regulatory)	0
Small deletions	0
Small insertions	0
Small indels	0
Gross deletions	0
Gross insertions & duplications	0
Complex rearrangements (including inversions)	0
Repeat variations	0
TOTAL	1

Accession Number	Codon	Nucleotide	Amino acid	Phenotype
CM970744	576	CAG-CGG	Gln-Arg	Atopy, association with

## Category 5 - Generation and Transmission of Nervous Impulses

### Prion protein

Mutation type	Total number of mutations
Nucleotide substitutions (missense / nonsense)	14
Nucleotide substitutions (splicing)	0
Nucleotide substitutions (regulatory)	0
Small deletions	0
Small insertions	0
Small indels	0
Gross deletions	0
Gross insertions & duplications	0
Complex rearrangements (including inversions)	0
Repeat variations	0
TOTAL	14



Accession Number	Codon	Nucleotide	Amino acid	Phenotype
CM890102	102	CCG-CTG	Pro-Leu	Gerstmann-Straeussler syndrome
CM930595	105	CCA-CTA	Pro-Leu	Gerstmann-Straeussler syndrome
CM890103	117	GCA-GTA	Ala-Val	Gerstmann-Straeussler syndrome
CM890104	129	cATG-GTG	Met-Val	Gerstmann-Straeussler syndrome
CM971202	171	AAC-AGC	Asn-Ser	Schizophrenia
CM910305	178	cGAC-AAC	Asp-Asn	Creutzfeld-Jakob syndrome
CM930596	180	cGTC-ATC	Val-Ile	Creutzfeld-Jakob syndrome
CM971203	183	cACA-GCA	Thr-Ala	Spongiform encephalopathy, familial
CM920588	198	TTC-TCC	Phe-Ser	Gerstmann-Straeussler syndrome
CM890105	200	cGAG-AAG	Glu-Lys	Creutzfeld-Jakob syndrome
CM961133	208	CGC-CAC	Arg-His	Creutzfeld-Jakob syndrome
CM930597	210	gGTT-ATT	Val-Ile	Creutzfeld-Jakob syndrome
CM920589	217	CAG-CGG	Gln-Arg	Gerstmann-Straeussler syndrome
CM930598	232	ATG-AGG	Met-Arg	Creutzfeld-Jakob syndrome

## Category 6 - Growth and Differentiation

### Vitamin D receptor

Mutation type	Total number of mutations
Nucleotide substitutions (missense / nonsense)	10
Nucleotide substitutions (splicing)	1
Nucleotide substitutions (regulatory)	0
Small deletions	0
Small insertions	0
Small indels	0
Gross deletions	0
Gross insertions & duplications	0
Complex rearrangements (including inversions)	0
Repeat variations	0
TOTAL	11

Accession Number	Codon	Nucleotide	Amino acid	Phenotype
CM971505	30	cCGA-TGA	Arg-Term	Rickets, vitamin D resistant
CM880062	33	GGC-GAC	Gly-Asp	Rickets, vitamin D resistant
CM961380	46	GGC-GAC	Gly-Asp	Rickets, vitamin D resistant
CM910389	50	CGA-CAA	Arg-Gln	Rickets, vitamin D resistant
CM880063	73	CGA-CAA	Arg-Gln	Rickets, vitamin D resistant
CM900227	80	CGG-CAG	Arg-Gln	Rickets, vitamin D resistant
CM930718	152	cCAG-TAG	Gln-Term	Rickets, vitamin D resistant
CM930719	274	CGC-CTC	Arg-Leu	Rickets, vitamin D resistant
CM890115	295	TACc-TAA	Tyr-Term	Rickets, vitamin D resistant
CM971506	305	CACa-CAG	His-Gln	Rickets, vitamin D resistant

Accession Number	IVS	Donor/ Acceptor	Relative location	Substitution	Phenotype
CS961654	4	ds	+5	G-C	Rickets, vitamin D resistant

The identification of the core group of genes considered to have an important effect

on the physiological and pathophysiological processes of disease enables attention to be focussed on ascertaining, identifying and cataloguing the genetic variation within the core group of genes utilising tried and tested technologies and techniques.

### **EXAMPLE 6**

#### **IDENTIFYING AND DETECTING POLYMORPHIC VARIATION IN THE CORE LIST OF GENES**

The human genome is known to be highly variable in different individuals. Variation exists in approximately one nucleic acid residue in every 300. Although a single nucleic acid change (single nucleotide polymorphism, SNP e.g. Schafer and Hawkins 1997, Nickerson et al 1998, Rieder et al 1998, SNP Consortium 1999) is the commonest form of genetic variation, other more complex forms also occur for example:

Type of variation	Example
Deletion	intronic deletion in the angiotensin converting enzyme gene
Insertion	144bp insertion in the prion gene
Repeats	Huntingtin gene in Huntington's chorea

These more complex forms of genetic variations account for more than 40% of the genetic changes associated with human disease.

Variations in human gene sequences, which are present in more than 1% of the population, are known as polymorphisms. These changes in genetic sequence can be detected by a variety of methods, which allow the direct sequencing and correct alignment of nucleotides (e.g. the Sanger method). However, this method is prone to error and multiple runs are required to ensure accuracy. More recently (Schafer and Hawkins 1997, Gilles et al 1999) many other techniques have been developed to, accurately and sensitively, identify the presence of polymorphic variation based on:

- restriction fragment length polymorphisms using Southern blots
- allele specific extensions of a detection primer using high fidelity enzymes
- scanning for single strand conformational polymorphisms
- gel mobility detection of heteroduplexes
- detection of denaturing gradient differences using gel electrophoresis
- ribonuclease cleavage of RNA:RNA or RNA:DNA heteroduplexes
- chemical cleavage of heteroduplex mismatches

- gel based detection of resolvase cleavage using T4 endonuclease
- radioactive labelling and multi-photon detection
- detection of altered banding patterns on gels using cleavage fragment length polymorphisms
- recognition of heteroduplex mismatches using E. Coli mismatch repair enzymes
- DNA variation detection using denaturing high performance liquid chromatography
- matrix assisted laser desorption/ionisation time of flight mass spectrometry
- electronic array of DNA probes on silicon microchips

Therefore, given an identified gene sequence, the technology to identify polymorphic variation is well established and is generally applicable to any section of the human genome. (Nickerson et al 1998, Wang et al 1998, Rieder et al 1999).

In addition computational approaches can also be used to search for and assess polymorphic variation in existing gene sequence databases (as confirmed by Buetow et al 1999).

Thus the methods of generating the nucleotide sequence required for the design of an array or chip is well known to those skilled in the art.

However, for the purposes of an array design it would be useful to establish the frequency of a given polymorphism in the general population and thus derive a way of assessing its likely clinical importance. Polymorphisms are defined as being a genetic variation present in more than 1% of the population. In order to determine the frequency of a polymorphism in a given population a number of individual DNA samples will need to be investigated. The table below provides the number of DNA samples, which will need to be examined in order to determine the frequency of polymorphisms at a particular threshold of statistical certainty.

## NUMBER OF DNA SAMPLES REQUIRED TO DETECT POLYMORPHISMS

Minimum Allele Frequency	Appears Once	Appears Twice	Statistical Certainty
> 1%	58	97	90%
	75	119	95%
	115	166	99%
> 5%	12	19	90%
	15	24	95%
	23	33	99%
> 10%	6	10	90%
	8	12	95%
	11	16	99%

E.g. if a particular variant appears twice in 166 DNA samples, we can be 99% sure that the variant allele is present in >1% of the population.

The technologies and methodologies required for the identification and tabulation of polymorphic variation are of considerable value in the identification of genetic variation, which will be informative in the practice of medicine.

This invention provides a means of fusing the genomic and pharmacological profiles together with their clinical associations in such a way as to enhance and enable the provision of individually tailored therapeutic packages for enhanced healthcare management.

In addition, the use of such devices and the tabulating of genomic variations that lead to or predispose to disease, will lead to revolutionary insights into the pathophysiology of diseases. These may well lead to the classical definitions of disease states being sub-divided or re-organised into specific genomic configurations, creating the potential for new therapeutic approaches (as indicated in Drews and Ryser 1997).

The actual demonstration of associations between disease, outcomes, adverse events or specific symptom clusters will emerge as the result of clinical trials and investigations using accepted approaches and methods.

#### **EXAMPLE 7 - ANALYSIS OF DATABASE TO ASCERTAIN GENOTYPE/PHENOTYPE RELATIONSHIPS**

The generation of genetic profiling data and its analysis alongside clinical information derived from patients presents considerable challenges for data handling and analysis. The volume of information, number of information categories and the variable nature of the information (e.g. dimensional or categorical) ensure that the operation of a database combining genetic and clinical information to generate a prognostic outcome is a complex task.

However, the complexity can be dealt with using existing analytical approaches. Association analysis between genetic polymorphisms can be dealt with by using standard statistical techniques (analysis of variance, meta-analysis etc) with appropriate corrections for multiple testing. The thresholds for statistical significance will be derived from scientific convention (e.g. significance at the 5% level following Bonnferroni correction). The data concerning genotype/phenotype relationships between the core group of genes and clinical signs and symptoms and therapeutic interventions will form a central component of the database.

The creation of a database containing and elaborating on such genotype/phenotype relationships will become an important tool for the practice of molecular medicine and the development of healthcare management. In order to derive benefit from such a database it must be capable (following interrogation using a patients profile of genetic variation derived from the core group of genes) of analysing the profile and providing a meaningful output to the healthcare professional which will provide guidance on the

prognosis, healthcare management and therapeutic interventions appropriate to the patient.

The generation of such an output can be achieved using machine learning algorithms. The genetic algorithm (Goldberg 1989, Fogarty and Ireson 1994) has been shown to provide a general process for achieving good results for search in large noisy domains. Starting from a population of randomly generated points in a search space, and given an evaluation of each of those points, the genetic algorithm is designed to converge the population to an optimum point in the search space. Processes of data selection, crossover, mutation and replacement of old members of the dataset achieve this with new members of more value. The effective use of the genetic algorithm process is a representation of the search space, which is responsive to the heuristics, embodied in the genetic operators.

The user must also supply an evaluation function identifying the degree to which the point in space approaches an optimum ('weighting') such that the selection operator for propagation through the dataset can choose them.

The genetic algorithm can be used to find predictively meaningful categories that is:

- intervals of continuous attribute values
- sets of nominal attribute values
- combinations of attributes

Together these attributes can create a simple Bayesian classifier for aspects of healthcare management.

Additional techniques (e.g. Bahadur-Lazarsfeld expansion) enable second order approximation of dependencies between predictive attributes. This allows the full complexity of the individual's genetic variation profile and the specifics of their clinical, psychological and social state to be assessed in order to produce an output concerning their prognosis, healthcare management and the possibilities for therapeutic intervention.

Assembly of such data will allow the merging of accepted treatment algorithms with the polymorphic variation underlying specific aspects of genomic functionality. This will produce new algorithms that will provide a prognostic indication for individual patients and, coupled with the expertise of their responsible clinician, allow the appropriate healthcare decisions to be made in a pro-active way.

The identification of genetic variation in the core list of genes and its application to healthcare management will have significant beneficial effects on the way in which clinicians will be able to formulate plans for healthcare management.

This will be seen in at least two ways. The first by enabling the targeting of resources at appropriate individuals (see Example 8) and the second by enabling an objective risk assessment of the optimum configuration for different types of therapeutic intervention (e.g drugs, surgery, radiotherapy, occupational therapy) and the identification of those patients at significant risk of suffering adverse events from

therapeutic intervention (see Example 9).

### **EXAMPLE 8 - CLINICAL MANAGEMENT OF FAMILIAL ADEMATOUS POLYPOSIS**

Familial adenomatous polyposis (FAP) is an autosomal dominant disorder which typically presents with colorectal cancer (CRC) in early adult life secondary to extensive adenomatous polyps of the colon. Polyps also develop in the upper gastrointestinal tract and malignancies may occur in other sites including the brain and the thyroid. Helpful diagnostic features include pigmented retinal lesions known as congenital hypertrophy of the retinal pigment, jaw cysts, sebaceous cysts, and osteomata. The APC gene at 5q21 is mutant in FAP.

#### **CLINICAL FEATURES**

Familial adenomatous polyposis (FAP) is characterized by adenomatous polyps of the colon and rectum; in extreme cases the bowel is carpeted with a myriad of polyps. This is an aggressive premalignant disease with one or more polyps progressing through dysplasia to malignancy in untreated gene carriers with a median age at diagnosis of 40 years. Carcinoma may arise at any age from late childhood through the seventh decade. The presenting features are usually those of malignancy, such as weight loss and inanition, bowel obstruction, or bloody diarrhea. Cases of new mutation still present in these ways but in areas with well organized registers most other gene carriers are detected by bowel examination while still asymptomatic. Occasionally, the extracolonic features of the condition lead to presentation.

Petersen et al. (1993) demonstrated the feasibility of presymptomatic direct detection of APC mutations in each of 4 families. No change in the conventional FAP colon screening regimen was recommended for children found to have a mutation. In contrast, when direct tests indicated that an individual did not have the mutation, they recommended that screening be decreased. Three of the mutations were nonsense mutations and one was a frameshift mutation due to insertion of 1 nucleotide. In an evaluation of molecular genetic diagnosis in the management of familial polyposis, Maher et al. (1993) concluded that intragenic and closely linked DNA markers are informative in most families and that, in addition to the clinical benefits of presymptomatic diagnosis, the reduction in screening for low-risk relatives means that molecular genetic diagnosis is a cost-effective procedure.

Davies et al. (1995) found that families with mutations 3-prime of codon 1444 had significantly more lesions on dental panoramic radiographs ( $P$  less than 0.001) and appeared to have a higher incidence of desmoid tumors than did families with mutations at the 5-prime end. All 7 families except one with mutations 5-prime of exon 9 did not express CHRPE. All of 38 individuals from 16 families with mutations between exon 9 and codon 1444 expressed CHRPE. The 11 individuals from 4 families with mutations 3-prime of codon 1444 did not express CHRPE. These results suggested that the severity of some of the features of Gardner syndrome may correlate with genotype in FAP.

Since an alteration of the APC gene occurs early in most colorectal tumors, detection of APC mutations in fecal tumor DNA could be a powerful tool for the diagnosis of noninvasive cancer. Deuter and Muller (1998) described a highly sensitive and nonradioactive heteroduplex-PCR method (HD-PCR) for detecting APC mutations in stool DNA.

Petersen et al. (1989) demonstrated how one could use linkage information to modify the standard recommendations for follow-up. For example, in the family of an affected 36-year-old man with a positive family history of APC, there were 4 asymptomatic children under the age of 10 years. Before linkage analysis, all children had a 50% risk. Screening protocols would call for annual sigmoidoscopy in all beginning at age 12 years. With the linkage information, one could state to the family with 98% confidence that 3 of the children did not inherit the gene and that 1 child did. That child could be screened annually; the others would have screening every 3 years beginning at ages 12 or 13 and continuing until age 35.

#### EXAMPLE 9 - GENETIC VARIATION IN DRUG TARGETS AND DRUG METABOLIZING ENZYMES

Therapeutic intervention by the use of drugs is a common mode of clinical treatment. However, this is not without difficulty (Weatherall, Leadingham and Warell 1996) and even hazard (Lazarou et al 1998). Drugs interact with the body in many different ways to produce their effect. Some drugs act as false substrates of inhibitors for transport systems (e.g. calcium channels) or enzymes (acetylcholinesterase). Most drugs however, produce their effects by acting on receptors, usually located in the cell membrane, which normally respond to endogenous chemicals in the body (Weatherall, Leadingham and Warrell 1996). Drugs that activate receptors and produce a response are called agonists (e.g. cholinomimetics). Antagonists combine with receptors but do not activate them, thus reducing the probability of the transmitter substance combining with the receptor and so blocking receptor activation. The ability of the drug to interact with the receptor depends on the specificity of the drug for the receptor or 'target' (Brody, Larner and Minneman 1998).

In addition to the main categories of agonist and antagonist, drugs also have mechanisms of action whereupon they interact with specific types of molecules - targets' - that include:

- blockade of uptake or transport sites (e.g. selective serotonin reuptake inhibitors)
- enzyme inhibition (e.g. angiotensin converting enzyme inhibitors, acetylcholinesterase inhibitors)
- blockade of ion channels (calcium channel antagonists, anaesthetics)

However, many drugs are known to vary in their efficacy and side effects from patient to patient. This variation in drug response will be associated with the polymorphic variation in the drug target.

#### CNS MARKETED DRUGS

Drug	Drug Target	P polymorphic?
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Tricyclic antidepressants (TCA)	Neurotransmitter (NA/5-HT) re-uptake proteins (NET & SERT)	✓
SSRIs	Selective serotonin transport re-uptake protein (SERT)	✓
MAOIs	Monoamine oxidase A & B	✓
Benzodiazepines (GABA facilitators)/GABA antagonists. Barbiturates.	<i>GABA receptors</i>	✓
Beta-blockers	Noradrenaline (beta-adrenergic) receptors	✓
Atypical antidepressants	Alpha-adrenoceptors	✓
Beta-adrenoceptors antagonists	Beta-adrenoceptors	
Dopamine blockers/ boosters	Dopamine receptors	✓
Dopamine blockers/ boosters/depleters	Dopamine transporter (DAT1)	✓
Anticholinergics (muscarinic antagonists)	Muscarinic receptors	✓
Anticholinergics (nicotinic antagonists)	Nicotinic receptors	✓
Anticholinesterases	Acetylcholinesterase (ACHE)	✓
COMT inhibitor	Catechol-O-methyltransferase (COMT)	✓
Sodium channel blocker	Sodium channel	✓
<i>Opioid analgesics &amp; antagonists</i>	Opioid receptors (OPRM1; OPRK1; OPRD1)	✓
Antipsychotics/neuroleptics (5-HT/D2 antagonists)	5-HT/D2 receptors	✓
Antiinflammatory drugs	Cyclooxygenase (COX1, COX2)	✓
Antihistamines	Histamine receptors	✓

#### CARDIOVASCULAR MARKETED DRUGS

Drug	Drug Target	Polymorphic?
ACE inhibitors	Angiotensin converting enzyme (ACE)	✓
HMG CoA reductase inhibitors, e.g simvastatin	HMG CoA reductase	✓
Angiotensin II antagonists	Angiotensinogen	✓
Calcium channel blocker	<i>Calcium channel</i>	✓
Thromboxane A2 synthase inhibitor	<i>Thromboxane A2 synthase</i>	✓
A2 receptor antagonist	<i>Thromboxane A2 receptor</i>	✓
Potassium channel blocker	<i>Potassium channel</i>	✓
Na-H ion exchange (NHE) inhibitor	<i>Na-H ion exchanger (NHE)</i>	✓
bile acid transport inhibitor	<i>SLC10A1 (sodium/bile acid cotransporter)</i>	✓
bile acid transport inhibitor	<i>SLC10A2 (sodium/bile acid cotransporter)</i>	✓



platelet aggregation inhibitor	Von Willebrand factor	✓
ACAT inhibitor	<i>Acetoacetyl-CoA-thiolase (ACAT)</i>	✓
Endothelin antagonist	<i>Endothelin (EDN3)</i>	✓

#### GASTROINTESTINAL (Peptic ulcer) MARKETED DRUGS

Drug	Drug Target	Polymorphic?
Proton pump inhibitor (e.g. omeprazole).	H <sup>+</sup> /K <sup>+</sup> adenosine triphosphatase (ATPase) enzyme system ('proton pump')	✓
H <sub>2</sub> antagonists (e.g. cimetidine)	Histamine H <sub>2</sub> -receptor	✓
Muscarinic antagonists (e.g. pirenepine)	Muscarinic m <sub>1</sub> & m <sub>3</sub> receptors	✓
Prostaglandins (inhibit cAMP)	<i>Adenylate cyclase, histamine-induced activity</i>	✓

Another problem the medical practitioner faces, is that certain patients may be particularly susceptible to drug addiction. Examples of drugs with known addictive properties are Amphetamines, Temazepam and Phenobarbitone, although having approved medicinal use e.g. phenobarbitone for epilepsy, they may cause problems of dependency and misuse in individuals. Knowledge of such an individual's susceptibility before prescribing certain drugs would be an advantage to the medical practitioner.

Any drug may produce unwanted or unexpected adverse events, these can range from trivial (slight nausea) to fatal (aplastic anaemia). One of the main reasons for adverse events following drug intake is the drug binding to a non specific or non target receptors in the body (Brody, Larner and Minneman 1998). Another reason is the interaction of the drug with other drugs given to the patient. This is a particular problem in the elderly who frequently suffer from multiple illnesses requiring many different classes of drugs and providing a real potential for drug interactions (Weatherall, Leadingham and Warrell 1996). The drug may also produce adverse events over time as the drug is absorbed, distributed, metabolised and excreted e.g. products of metabolising the drug may be reactive themselves and be toxic to the body. Being able to predict the likelihood of a particular individual suffering from an adverse event and the severity of that event would be an important tool for the practitioner. Many of the important components of the biological pathways involved in drug metabolism are coded by genes containing polymorphic variation.

#### METABOLISING ENZYMES

Drug	Drug-metabolising enzyme	Polymorphic?
Most	Cytochrome P450 enzyme, CYP2C19	✓
Most	Cytochrome P450 enzyme, CYP2D6	✓
Most	UDP-glucuronosyltransferase	✓
Most	N-acetyltransferase (NAT1)	✓

Brain damage	Head injury, mental retardation, epilepsy, stroke, seizures, brain tumors
Dementia	Alzheimer's, Parkinson's, Huntington's, prion diseases, epilepsy, neurodegeneration,
Psychoses & personality	Schizophrenia, OCD, depression, bipolar affective disorder
Cardiovascular	Heart failure, hypertension, vasculitis, arrhythmia, cholesterolaemia, cardiomyopathy, atherosclerosis, valvular disease, coarctation, aneurysms, blood disorders, COPD.
Gastrointestinal	Gastric ulcers, duodenal ulcers, peptic ulcers, kidney disease, liver, pancreas, urinary, GERD (heartburn), nausea, diabetes mellitus, obesity
Respiratory	Lungs, anoxia, hypoxia, breathing problems, asthma, COPD, allergies
Immunity	Injury, inflammation, infection, AIDS
Development	Growth, differentiation, developmental disorders.
Skin, bone, muscle	Cornea disease, abnormal pigmentation, conductive hearing loss, arthritis, osteoporosis, myopathies, muscular atrophy, myositis, myoblastoma, eczema, dermatitis.
Metabolic & endocrine	Metabolism, reproduction, obesity Hormone action, diabetes
Headache	Migraine; trauma, infection
Sexual dysfunction	Infertility, impotency, male erectile dysfunction, female reproductive disorders

In a first aspect.

## **ADME (ABSORPTION, DISTRIBUTION, METABOLISM & ELIMINATION) & TOXICOLOGY**

The invention relates to a method of assessing the most appropriate therapeutic intervention in an individual, patient, group or population suffering from the debilitating consequences of dysfunction, damage or disease of the body and its systems.

People vary enormously in their response to disease and also in their response to therapeutic interventions aimed at ameliorating the disease process and its progression. However, the provision of medical care and medical management is centered around observations and protocols developed in clinical trials on groups or cohorts of patients plan (Wetherall, Leadingham and Warrell 1996). This group data is used to derive a standardised method of treatment which is subsequently applied on an individual basis (e.g. the comment that drugs are often prescribed on the basis that everyone is an 70kg white male).

It is standard practice for clinicians to prescribe the same starting dose of a particular drug for a given indication and then adjust the treatment regimen by monitoring the progress of the disease and therapeutic response in individual patients. Observation of *actual* therapeutic outcome following these adjustments to patients therapy provides, the basis for determining a prognosis for the disease and developing a clinical management plan for patient care (eg. see Fig 1, algorithm for management of schizophrenia, from Fig 1 Taylor and Kerwin 1997, Fig 2 algorithm for treatment of depression from Fig 1 Pathare and Paton 1997).

The standard practice of clinical management has its disadvantages. In particular it is retro-active in that changes to patient management will occur following the emergence of therapeutic failures, adverse events or other difficulties in undertaking the therapeutic regime.

The toxicological effect of any treatment involves four main pathways, Absorption, Distribution, Metabolism and Elimination, better known as ADME. The most important axiom of toxicology is that "the dose makes the poison". Therefore variation in genes affecting the Absorption, Distribution, Metabolism and Elimination (ADME) of 'therapeutic' substances, accounts for much of the difference in individuals risk of toxicity.

Drugs interact with the body in many different ways to produce their effect. Some drugs act as false substrates of inhibitors for transport systems (e.g. calcium channels) or enzymes (acetylcholinesterase). Most drugs however, produce their effects by acting on receptors, usually located in the cell membrane, which normally respond to endogenous chemicals in the body (Weatherall, Leadingham and Warrell 1996).

Drugs that activate receptors and produce a response are called agonists (e.g. cholinomimetics). Antagonists combine with receptors but do not activate them, thus reducing the probability of the transmitter substance combining with the receptor and

so blocking receptor activation. The ability of the drug to interact with the receptor depends on the specificity of the drug for the receptor or 'target' (Brody, Larner and Minneman 1998).

In addition to the main categories of agonist and antagonist drugs also have mechanisms of action which include:

- blockade of uptake or transport sites (e.g. selective serotonin reuptake inhibitors)
- enzyme inhibition (e.g. angiotensin converting enzyme inhibitors, acetylcholinesterase inhibitors)
- blockade of ion channels (calcium channel antagonists, anaesthetics)

Any drug may produce unwanted or unexpected adverse events, these can range from trivial (slight nausea) to fatal (aplastic anaemia). According to a recent article published in *JAMA* (Lazarou J, Pomeranz BH, Corey PN. 1998. *Incidence of adverse drug reactions in hospitalised patients: a meta-analysis of prospective studies. JAMA Apr 15; 279 (15): 1200-5*), in 1994, in US, 106,000 deaths were caused by adverse drug reactions, making ADRs the fourth leading cause of death in US. One of the main reasons for adverse events following drug intake is the drug binding to non-specific or non-target receptors in the body (Brody, Larner and Minneman 1998). Another reason is the interaction of the drug with other drugs given to the patient. This is a particular problem in the elderly who frequently suffer from multiple illnesses requiring many different classes of drugs and providing a real potential for drug interactions (Weatherall, Ledingham and Warrell 1996). The drug may also produce adverse events over time as the drug is absorbed, distributed, metabolised and excreted e.g. products of metabolising the drug may be reactive themselves and be toxic to the body. Being able to predicting the likelihood of particular individuals suffering from an adverse event and the severity of that event would be important tool for the practitioner.

Another problem the medical practitioner faces, is that certain patients may be particularly susceptible to drug addiction. Examples of drugs with known addictive properties are Amphetamines, Temazepam and Phenobarbitone, although having approved medicinal use e.g. phenobarbitone for epilepsy, they may cause problems of dependency and misuse in individuals. Knowledge of such an individual's susceptibility before prescribing certain drugs would be an advantage to the medical practitioner.

The core list of genes for the ADME Genostic, would prove of considerable value in aiding decisions concerning the appropriateness and relevance of therapeutic interventions using many drugs. The use of the ADME Genostic would be of considerable utility in determining the likelihood and magnitude of therapeutic response, complications from drug-drug interactions, the potential for adverse events and the difficulties that might arise due to previous, concurrent or future dysfunction, damage or disease of body systems in an individual, patient, group or population. All of these factors are of considerable importance in enabling the selection and monitoring of therapeutic interventions and effective healthcare management.

In addition, the core list of genes in the ADME genostic would also be of considerable

utility in enhancing the analysis of clinical trial data derived from drugs in development.

A list of drugs currently on the market can be found in standard works of reference, in particular the British National Formulary, 1998, the Dental Practitioners' Formulary, 1998, Martindale, 1998, Herbal medicines, 1998. Drugs available in the United States can be found in U.S. Pharmacopeia, 1998, and drugs available in Japan can be found in Iryoyaku Nihon Iyakuhinshu, 1998, Ippanyaku Nihon Iyakuhinshu, 1998 and Hokenyaku Jiten, 1998. Drugs available in other countries can be found in the appropriate National Formularies. A list of drugs currently under development worldwide can be found in current journals and text (Pipeline pulse, 1999, Scrip, 1998, IDrugs, 1998, Current Opinion in Drug Discovery and Development, 1998).

In a recent review entitled, 'Drug-metabolism research challenges in the new millenium: individual variability in drug therapy and drug safety', it has been stated that:

" with the rapid progress in the understanding of genetic polymorphism and the development of genechip technology, it becomes quite feasible for individuals to be genotyped with respect to critical genes targeted for drug intervention and genes essential for drug transport and metabolism.....the (future) objective is to identify key genetic variations that could impact drug response and drug safety." A.Y.H. Lu, (1998) *Drug metabolism and disposition*, Vol 26 (12) p1217-1222.

There is a wealth of information available on the genetic polymorphisms of enzymes involved in drug metabolism. Genetic variation in genes coding for proteins which act as drug metabolising enzymes, drug transporters, DNA repair enzymes, or drug targets can lead to the production of defective enzymes or altered receptor binding affinities. This can have profound effects on the drug efficacy, drug safety and optimal drug dosage. The genetic variation in these genes has been identified and is included in our ADME core list of genes.

The following tables give examples of genes in which polymorphisms are known to be associated with variation in response to drugs.

#### DRUG ABSORPTION

Drug	Drug-transporter, membrane protein	Polymorphic?
All	P-glycoprotein 1 (MDR1)	✓
All	P-glycoprotein 3 (MDR3)	✓

#### DRUG DISTRIBUTION

Drug	Drug-binding plasma protein	Polymorphic?
All	Serum albumin (ALB)	✓
All	Alpha 1 acid glycoprotein (AAG)	✓
All	Canalicular multispecific organic anion transporter (CMOAT or MRP2)	✓

All	Multidrug resistance associated protein (MRP1)	✓
All	Cytokine-suppressive antiinflammatory drug-binding protein 1 (CSBP1)	✓

### DRUG METABOLISM

Drug	Drug-metabolising enzyme	Polymorphic?
All	Cytochrome P450 enzymes (CYP2C19; CYP2D6)	✓
All	UDP-glucuronosyltransferase	✓
All	N-acetyltransferase (NAT1)	✓
All	NADPH-cytochrome p450 reductase	✓

### DRUG ELIMINATION

Drug	Drug-excretion protein	Polymorphic?
All	Bile salt export pump (BSEP)	✓
All	Sodium/bile acid cotransporter, (SLC10A1; SLC10A2)	✓

### DRUG TARGETS FOR CNS MARKETING DRUGS

Drug	Drug Target	Polymorphic?
Tricyclic antidepressants (TCA)	Neurotransmitter (NA/5-HT) re-uptake proteins (NET & SERT)	✓
SSRIs	Selective serotonin transport re-uptake protein (SERT)	✓
MAOIs	monoamine oxidase A & B	✓
Benzodiazepines (GABA facilitators)/GABA antagonists. Barbiturates.	GABA receptors	✓
Beta-blockers	Noradrenaline (beta-adrenergic) receptors	✓
Atypical antidepressants	Alpha-adrenoceptors	✓
Beta-adrenoceptors antagonists	Beta-adrenoceptors	
Dopamine blockers/ boosters	Dopamine receptors	✓
Dopamine blockers/ boosters/depleters	Dopamine transporter (DAT1)	✓
Anticholinergics (muscarinic antagonists)	Muscarinic receptors	✓
Anticholinergics (nicotinic antagonists)	Nicotinic receptors	✓
Anticholinesterases	Acetylcholinesterase (ACHE)	✓
COMT inhibitor	Catechol-O-methyltransferase (COMT)	✓
Sodium channel blocker	Sodium channel	✓

Opioid analgesics & antagonists	Opioid receptors (OPRM1; OPRK1; OPRD1)	✓
Antipsychotics/neuroleptics (5-HT/D2 antagonists)	5-HT/D2 receptors	✓
Antiinflammatory drugs	Cyclooxygenase (COX1, COX2)	✓
Antihistamines	Histamine receptors	✓

### DRUG TARGETS FOR CNS DRUGS IN DEVELOPMENT

Drug	Drug Target	Polymorphic?
Selective NAT inhibitors (SNRIs)	Noradrenaline transport reuptake protein (NAT1 or NET)	✓
5-HT1A-agonist	5-HT1A receptor (HTR1A)	✓
Selective 5-HT2A antagonist	5-HT2A receptor (HTR2A)	✓
Clozapine (MAOI)	5-HT2C receptor (HTR2C)	✓
Glycine antagonist	Glycine receptor (GLRA2)	✓
Cannabinoid receptor agonist (THC)	Cannabinoid receptor (CNR1)	✓
Calcium channel blocker	Calcium channels	✓

### DRUG TARGETS FOR CARDIOVASCULAR MARKETING DRUGS

Drug	Drug Target	Polymorphic?
ACE inhibitors	Angiotensin converting enzyme (ACE)	✓
HMG CoA reductase inhibitors, e.g simvastatin	HMG CoA reductase	✓
Angiotensin II antagonists	Angiotensinogen (AGT)	✓
Calcium channel blocker	Calcium channel	✓
Thromboxane A2 synthase inhibitor	Thromboxane A2 synthase	✓
A2 receptor antagonist	Thromboxane A2 receptor	✓
Potassium channel blocker	Potassium channel	✓
Na-H ion exchange (NHE) inhibitor	Na-H ion exchanger (NHE)	✓
bile acid transport inhibitor	SLC10A1 (sodium/bile acid cotransporter)	✓
bile acid transport inhibitor	SLC10A2 (sodium/bile acid cotransporter)	✓
platelet aggregation inhibitor	Von Willebrand factor	✓
ACAT inhibitor	Acetoacetyl-CoA-thiolase (ACAT)	✓
Endothelin antagonist	Endothelin (EDN3)	✓

### DRUG TARGETS FOR GASTROINTESTINAL DISEASE (Peptic ulcer) MARKETING DRUGS

Drug	Drug Target	Polymorphic?
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Proton pump inhibitor (e.g. omeprazole).	H <sup>+</sup> /K <sup>+</sup> adenosine triphosphatase (ATPase) enzyme system ('proton pump')	✓
H <sub>2</sub> antagonists (e.g. cimetidine)	Histamine H <sub>2</sub> -receptor	✓
Muscarinic antagonists (e.g. pirenepine)	Muscarinic m <sub>1</sub> & m <sub>3</sub> receptors	✓
Prostaglandins (inhibit cAMP)	Adenylate cyclase, histamine-induced activity	✓

### DRUG TARGETS FOR RESPIRATORY DISEASE (Asthma & Allergy) MARKETING DRUGS

Drug	Drug Target	Polymorphic?
Beta-2- agonists (Bronchodilators)	Beta-2-adrenoceptor	✓
Muscarinic antagonists (Bronchodilators)	Muscarinic receptors	✓
Histamine antagonists (Antihistamines)	Histamine receptors	✓
Thromboxane A <sub>2</sub> synthase inhibitor	Thromboxane A <sub>2</sub> synthase	✓
A <sub>2</sub> receptor antagonist	Thromboxane A <sub>2</sub> receptor	✓

### DNA REPAIR

Drug	DNA repair enzyme	Polymorphic?
All	O(6)-methylguanine-DNA methyltransferase (MGMT)	✓
All	DNA damage binding protein (DDB1)	✓
All	DNA-damage-inducible transcript 3 (DDIT3)	✓
All	RAD52	✓

We have elaborated on the value and utility to be derived from the gathering together of the genes which form the core gene list for this particular Genostic system.

These genes are elaborated below:

#### KEY TO 'PROTEIN FUNCTION' COLUMN

E ENZYME  
T TRANSPORT & STORAGE  
S STRUCTURAL  
I IMMUNITY  
N NERVOUS TRANSMISSION  
G GROWTH & DIFFERENTIATION



**ADME GENE LIST**

	<b>HUGO gene symbol</b>	<b>Protein function</b>
5-adenosyl homocysteine hydrolase		E
Acetoacetyl 1-CoA-thiolase	ACAT1	E
Acetoacetyl 2-CoA-thiolase	ACAT2	E
Acetyl CoA acyltransferase	ACAA	E
Acetylcholine receptor, nicotinic, alpha A1	CHRNA1	N
Acetylcholine receptor, nicotinic, alpha A2	CHRNA2	N
Acetylcholine receptor, nicotinic, alpha A3	CHRNA3	N
Acetylcholine receptor, nicotinic, alpha A4	CHRNA4	N
Acetylcholine receptor, nicotinic, alpha A5	CHRNA5	N
Acetylcholine receptor, nicotinic, alpha A6	CHRNA6	N
Acetylcholine receptor, nicotinic, alpha A7	CHRNA7	N
Acetylcholine receptor, nicotinic, beta 1	CHRNA1	N
Acetylcholine receptor, nicotinic, beta 2	CHRNA2	N
Acetylcholine receptor, nicotinic, beta 3	CHRNA3	N
Acetylcholine receptor, nicotinic, beta 4	CHRNA4	N
Acetylcholine receptor, nicotinic, epsilon	CHRNA5	N
Acetylcholine receptor, nicotinic, gamma	CHRNA6	N
Acetylcholinesterase	ACHE	E
Actin, alpha, cardiac	ACTC	S
Actin, alpha, skeletal	ACTA1	S
Actin, alpha, smooth, aortic	ACTA2	S
Actin, beta	ACTB	S
Actin, gamma 2	ACTG2	S
Acyl CoA dehydrogenase, short chain	ACADS	E
Adenine phosphoribosyltransferase	APRT	T
Adenosine deaminase	ADA	E
Adenosine monophosphate deaminase	AMPD	E
Adenosine receptor A1	ADORA1	N
Adenosine receptor A2A	ADORA2A	N
Adenosine receptor A2B	ADORA2B	N
Adenosine receptor A3	ADORA3	N
Adenylate cyclase 1	ADCY1	E
Adenylate cyclase 2	ADCY2	E
Adenylate cyclase 3	ADCY3	E
Adenylate cyclase 4	ADCY4	E
Adenylate cyclase 5	ADCY5	E
Adenylate cyclase 6	ADCY6	E
Adenylate cyclase 7	ADCY7	E
Adenylate cyclase 8	ADCY8	E
Adenylate cyclase 9	ADCY9	E
Adenylate kinase	AK1	E
Adenylate transferase		E
Adenylosuccinate lyase	ADSL	E
ADP-ribosyltransferase	ADPRT	E
Adrenergic receptor, alpha1	ADRA1	N
Adrenergic receptor, alpha2	ADRA2	N

Adrenergic receptor, beta1	ADRB1	N
Adrenergic receptor, beta2	ADRB2	N
Adrenergic receptor, beta3	ADRB3	N
Adrenocorticotrophic hormone (ACTH) receptor	ACTHR	G
Adrenoleukodystrophy gene	ALD	E
Albumin, ALB	ALB	T
Alkaptonuria gene	AKU	G
Alpha 1 acid glycoprotein	AAG; AGP	T
alpha1-antitrypsin	PI	E
alpha2-antiplasmin	PLI	E
alpha-amylase		E
Alpha-fetoprotein	AFP	G
alpha-glucosidase, neutral AB	GANAB	E
alpha-glucosidase, neutral C	GANC	E
Aminomethyltransferase	AMT	E
Aminopeptidase P	XPNPEP2	E
Amyloid beta (A4) precursor protein-binding, APBB1	APBB1	N
Amyloid beta A4 precursor protein	APP	N
Androgen binding protein	ABP	T
Androgen receptor	AR	G
Angiotensin converting enzyme	ACE, DCP1	E
Angiotensin receptor 1	AGTR1	T
Angiotensin receptor 2	AGTR2	T
Angiotensinogen	AGT	E
Annexin 1	ANX 1	I
Apurinic endonuclease	APE	E
Arginine vasopressin	AVP	N
Arginine vasopressin receptor 1A	AVPR1A	N
Arginine vasopressin receptor 1B	AVPR1B	N
Arginine vasopressin receptor 2	AVPR2	N
Aryl hydrocarbon receptor	AHR	T
Arylsulfatase E	ARSE	E
Aspartate transcarbamoylase		E
Ataxia telangiectasia gene, AT	ATM	G
ATP cobalamin adenosyltransferase		E
ATP sulphurylase	atpsk2	E
ATP/ADP translocase		E
Atrial natriuretic peptide	ANP	G
Atrial natriuretic peptide receptor A	NPR1	G
Atrial natriuretic peptide receptor B	NPR2	G
Atrial natriuretic peptide receptor C	NPR3	G
BCL2-associated X protein	BAX	G
Benzodiazepine receptor		N
beta-endorphin receptor		N
Bile acid coenzyme A: amino acid N-acyltransferase	BAAT	E

Bile salt export pump	BSEP, PFIC2	T
Bile salt-stimulated lipase	CEL	E
Bilirubin UDP-glucuronosyltransferase		E
Biliverdin reductase		T
Bleomycin hydrolase	BLMH	E
Bradykinin receptor B1		I
Bradykinin receptor B2		I
Breakpoint cluster region	BCR	G
Breast cancer 1	BRCA1	G
Breast cancer 2	BRCA2	G
Brush border guanylyl cyclase		E
Butyrylcholinesterase	BCHE	E
Ca(2+) transporting ATPase, fast twitch	ATP2A1	T
Ca(2+) transporting ATPase, slow twitch	ATP2A2	T
Calcineurin A1	CALNA1	I
Calcineurin A2	CALNA2	I
Calcineurin A3	CALNA3	I
Calcineurin B		I
Calcitonin receptor /Calcitonin gene-related peptide receptor	CALCR	N
Calcium channel, voltage-dependent, alpha 1F subunit	CACNA1F	N
Calcium channel, voltage-dependent, Alpha-1B (CACNL1A5)	CACNA1B	N
Calcium channel, voltage-dependent, Alpha-1C	CACNA1C	N
Calcium channel, voltage-dependent, Alpha-1D	CACNA1D	N
Calcium channel, voltage-dependent, Alpha-1E (CACNL1A6)	CACNA1E	N
Calcium channel, voltage-dependent, Alpha-2/delta	CACNA2	N
Calcium channel, voltage-dependent, Beta 1	CACNB1	N
Calcium channel, voltage-dependent, Beta 3	CACNB3	N
Calcium channel, voltage-dependent, L type, alpha 1S subunit	CACNA1S	N
Calcium channel, voltage-dependent, Neuronal, Gamma	CACNG2	N
Calcium channel, voltage-dependent, P/Q type, alpha 1A subunit	CACNA1A	N
Calcium channel, voltage-dependent, T-type		N
Canalicular multispecific organic anion transporter	CMOAT	T
Cannabinoid receptor	CNR1	N
Carbamoylphosphate synthetase 1	CPS1	E
Carbamoylphosphate synthetase 2	CPS2	E
Carbonic anhydrase 3	CA3	E
Carbonic anhydrase 4	CA4	E

Carbonic anhydrase, alpha	CA1	E
Carbonic anhydrase, beta	CA2	E
Carnitine transporter protein	CDSP, SCD	T
Carnosinase		N
Cartilage-hair hypoplasia gene	CHH	N
Catalase	CAT	I
Catechol-O-methyltransferase	COMT	E
Catenin, beta	CTNNB1	G
Cell adhesion molecule, vascular, VCAM	VCAM1	G
Cholecystokinin	CCK	N
Cholecystokinin B receptor	CCKBR	N
Cholesterol ester transfer protein	CETP	T
Choline acetyltransferase	CHAT	E
CoA transferase		E
Colony-stimulating factor 1	CSF1	G
Colony-stimulating factor 2	CSF2	G
Colony-stimulating factor 3	CSF3	G
Colony-stimulating factor 3 receptor	CSF3R	G
Complex V	MTATP6	E
Coproporphyrinogen oxidase	CPO	E
Cortico-steroid binding protein		T
Corticosteroid nuclear receptor		I
Corticotrophin-releasing hormone receptor	CRHR1	T
Creb binding protein	CREBBP	G
Crystallin, alpha A	CRYAA	S
Crystallin, alpha B	CRYAB	S
Crystallin, beta B2	CRYBB2	S
Crystallin, gamma A	CRYGA	S
Cu <sup>2+</sup> transporting ATPase alpha polypeptide	ATP7A	E
Cu <sup>2+</sup> transporting ATPase beta polypeptide	ATP7B	E
Cyclic AMP response element binding protein	CREB	G
Cyclic AMP response element modulator	CREM	G
Cyclic AMP-dependent protein kinase	PKA	E
Cyclic nucleotide phosphodiesterase 1B	PDE1B	E
Cyclic nucleotide phosphodiesterase 1B1	PDE1B1	E
Cyclic nucleotide phosphodiesterase 2A3	PDE2A3	E
Cyclic nucleotide phosphodiesterase 3A	PDE3A	E
Cyclic nucleotide phosphodiesterase 3B	PDE3B	E
Cyclic nucleotide phosphodiesterase 4A	PDE4A	E
Cyclic nucleotide phosphodiesterase 4C	PDE4C	E
Cyclic nucleotide phosphodiesterase 5A	PDE5A	E
Cyclic nucleotide phosphodiesterase 6A	PDE6A	E
Cyclic nucleotide phosphodiesterase 6B	PDE6B	E
Cyclic nucleotide phosphodiesterase 7	PDE7	E
Cyclic nucleotide phosphodiesterase 8	PDE8	E
Cyclic nucleotide phosphodiesterase 9A	PDE9A	E
Cyclin F	CCNF	G
Cyclin-dependent kinase inhibitor 1A (P21,	CDKN1A	G

CIP1)		
Cyclooxygenase 1	COX1	E
Cyclooxygenase 2	COX2	E
Cyclophilin		I
CYP11A1	CYP11A1	E
CYP11B1	CYP11B1	E
CYP11B2	CYP11B2	E
CYP17	CYP17	E
CYP19	CYP19	E
CYP1A1	CYP1A1	E
CYP1A2	CYP1A2	E
CYP1B1	CYP1B1	E
CYP21	CYP21	E
CYP24	CYP24	E
CYP27	CYP27	E
CYP27B1	PDDR	E
CYP2A1	CYP2A1	E
CYP2A13	CYP2A13	E
CYP2A3	CYP2A3	E
CYP2A6V2	CYP2A6V2	E
CYP2A7	CYP2A7	E
CYP2B6	CYP2B6	E
CYP2C18	CYP2C18	E
CYP2C19	CYP2C19	E
CYP2C8	CYP2C8	E
CYP2C9	CYP2C9	E
CYP2D6	CYP2D6	E
CYP2E1	CYP2E1	E
CYP2F1	CYP2F1	E
CYP2J2	CYP2J2	E
CYP3A3	CYP3A3	E
CYP3A4	CYP3A4	E
CYP3A5	CYP3A5	E
CYP3A7	CYP3A7	E
CYP4A11	CYP4A11	E
CYP4B1	CYP4B1	E
CYP4F2	CYP4F2	E
CYP4F3	CYP4F3	E
CYP51	CYP51	E
CYP5A1	CYP5A1	E
CYP7A	CYP7A	E
CYP8	CYP8	E
Cystic fibrosis transmembrane conductance regulator, CFTR	CFTR	N
Cytidine deaminase	CDA	E
Cytidine-5-prime-triphosphate synthetase	CTPS	E
Cytokine-suppressive antiinflammatory drug- binding protein 1	CSBP1	I

Cytokine-suppressive antiinflammatory drug-binding protein 2	CSBP2	I
Deoxycytidine kinase DCK		E
Deoxyuridine triphosphatase; dUTPase		E
DHEA sulfotransferase	STD	E
Dihydrodiol dehydrogenase 1	DDH1	E
Dihydrofolate reductase	DHFR	E
Dihydrolipoamide branched chain transacylase	DBT	N
Dihydrolipoamide dehydrogenase	DLD	N
Dihydrolipoyl dehydrogenase 2	PDHA	E
Dihydrolipoyl transacetylase	PDHA	E
Dihydroorotase		E
Dihydropyrimidine dehydrogenase	DPYD	E
Disrupted meiotic cDNA 1, homolog	DMC1	G
DNA damage binding protein, DDB1	DDB1	S
DNA damage binding protein, DDB2	DDB2	S
DNA directed polymerase, alpha	POLA	E
DNA glycosylases		E
DNA helicases		E
DNA Ligase 1	LIG1	E
DNA methyltransferase	DNMT	E
DNA polymerase 1		E
DNA polymerase 2		E
DNA polymerase 3		E
DNA primase		E
DNA-damage-inducible transcript 3	DDIT3	S
DNA-dependant RNA polymerase		E
Dopamine receptors D1	DRD1	N
Dopamine receptors D2	DRD2	N
Dopamine receptors D3	DRD3	N
Dopamine receptors D4	DRD4	N
Dopamine receptors D5	DRD5	N
Erythropoietin	EPO	I
Erythropoietin receptor	EPOR	I
Estrogen receptor	ESR	G
Excision repair complementation group 1 protein	ERCC1	E
Excision repair complementation group 2 protein	ERCC2	E
Excision repair complementation group 2 protein	ERCC3	E
Excision repair complementation group 4 protein	ERCC4	E
Excision repair complementation group 6 protein	ERCC6	E
Factor H	HF1	I
Factor IX	F9	I
Factor VII	F7	I

Factor VIII	F8	I
Factor X	F10	I
Fatty acid binding proteins FABP1		T
Fatty acid binding proteins FABP2	FABP2	T
Fatty acid binding proteins FABP3		T
Fatty acid binding proteins FABP4		T
Fatty acid binding proteins FABP5		T
Fatty acid binding proteins FABP6		T
Fibroblast growth factor	FGF1	G
Flavin-containing monooxygenase 1	FMO1	E
Flavin-containing monooxygenase 2	FMO2	E
Flavin-containing monooxygenase 3	FMO3	E
Flavin-containing monooxygenase 4	FMO4	E
Folic acid receptor	FOLR	G
Follicle stimulating hormone receptor	FSHR, ODG1	G
Follicle stimulating hormone, FSH	FSHB	G
Forkhead transcription factor 10	FKHL10	G
Forkhead transcription factor 14	FKHL14	G
Forkhead transcription factor 7	FKHL7	G
G/T mismatch binding protein	GTBP, MSH6	G
GABA receptor, alpha 1	GABRA1	N
GABA receptor, alpha 2	GABRA2	N
GABA receptor, alpha 3	GABRA3	N
GABA receptor, alpha 4	GABRA4	N
GABA receptor, alpha 5	GABRA5	N
GABA receptor, alpha 6	GABRA6	N
GABA receptor, beta 1	GABRB1	N
GABA receptor, beta 2	GABRB2	N
GABA receptor, beta 3	GABRB3	N
GABA receptor, gamma 1	GABRG1	N
GABA receptor, gamma 2	GABRG2	N
GABA receptor, gamma 3	GABRG3	N
GABA transaminase	ABAT	E
Gadd45 (growth arrest & DNA-damage-inducible protein)		E
Galactose 1-phosphate uridyl-transferase	GALT	E
Gamma-glutamyl carboxylase	GGCX	T
Gamma-glutamyltransferase 1	GGT1	T
Gamma-glutamyltransferase 2	GGT2	T
Gastric inhibitory polypeptide receptor, GIPR	GIPR	T
Gastric lipase, LIPF		T
Glucagon receptor	GCGR	G
Glucocorticoid receptor	GRL	G
Glucosaminyl (N-acetyl) transferase 2, l- branching enzyme	GCNT2	E
Glucosidase, acid beta	GBA	E
Glutamate decarboxylase, GAD	GAD1	E
Glutamate receptor 1	GLUR1	N
Glutamate receptor 2	GLUR2	N

Glutamate receptor 3	GLUR3	N
Glutamate receptor 4	GLUR4	N
Glutamate receptor 5	GLUR5	N
Glutamate receptor 6	GLUR6	N
Glutamate receptor 7	GLUR7	N
Glutamate receptor, ionotropic, NMDA 1	NMDAR1	N
Glutamate receptor, ionotropic, NMDA 2A	NMDAR2A	N
Glutamate receptor, ionotropic, NMDA 2B	NMDAR2B	N
Glutamate receptor, ionotropic, NMDA 2C	NMDAR2C	N
Glutamate receptor, ionotropic, NMDA 2D	NMDAR2D	N
Glutamine phosphoribosylpyrophosphate amidotransferase/PRPP amidotransferase		E
Glutathione	GSH	T
Glutathione peroxidase, GPX1	GPX1	E
Glutathione peroxidase, GPX2	GPX2	E
Glutathione reductase, GSR	GSR	E
Glutathione S-transferase mu 1, GSTM1	GSTM1	E
Glutathione S-transferase mu 4, GSTM4		E
Glutathione S-transferase theta 1, GSTT1	GSTT1	E
Glutathione S-transferase theta 2, GSTT2		E
Glutathione S-transferase, GSTP1	GSTP1	E
Glutathione S-transferase, GSTZ1	GSTZ1	E
Glutathione synthetase	GSS	E
Glyceraldehyde-3-phosphate dehydrogenase, GAPDH	GAPDH	E
Glycinamide ribonucleotide (GAR) transformylase	GART	E
Glycine receptor, alpha	GLRA2	N
Glycine receptor, beta		N
Glycine transporter	GLYT	N
Gonadotropin releasing hormone	GNRH	G
Gonadotropin releasing hormone receptor	GNRHR	G
Growth arrest-specific homeobox	GAX	G
Growth hormone 1	GH1	G
Growth hormone 2 (placental)	GH2	G
Growth hormone receptor	GHR	G
Growth hormone releasing hormone (GHRH)	GHRH	G
Growth hormone releasing hormone receptor	GHRHR	G
GTP cyclohydrolase 1	GCH1	G
GTPase-activating protein, GAP	RASA1	G
Guanidinoacetate N-methyltransferase	GAMT	E
Guanine nucleotide-binding protein, alpha activating activity polypeptide, GNAO	GNAO1	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 1, GNAI1	GNAI1	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 2, GNAI2	GNAI2	N
Guanine nucleotide-binding protein, alpha	GNAI3	N



inhibiting activity polypeptide 3, GNAI3		
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS1	GNAS1	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS2	GNAS2	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS3	GNAS3	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS4	GNAS4	N
Guanine nucleotide-binding protein, alpha transducing activity polypeptide, GNAT1	GNAT1	N
Guanine nucleotide-binding protein, alpha transducing activity polypeptide, GNAT2	GNAT2	N
Guanine nucleotide-binding protein, beta polypeptide 3	GNB3	N
Guanine nucleotide-binding protein, gamma polypeptide 5	GNG5	N
Guanine nucleotide-binding protein, q polypeptide	GNAQ	N
Guanylate cyclase 2D, membrane (retina-specific)	GUCY2D	E
Guanylate cyclase activator 1A (retina)	GUCA1A	E
Guanylate kinase		E
Guanylin	GUCA2	T
Guanylyl cyclase		E
H(+), K(+) - ATPase	ATP4B	N
Heat shock protein, HSP60		I
Heat shock protein, HSP70		I
Heat shock protein, HSP90		I
Hemopexin	HPX	I
Hepatic lipase	LIPC	E
Histamine receptors, H1		N
Histamine receptors, H2		N
Histamine receptors, H3		N
HLH transcription factor HAND1	HAND1	G
HLH transcription factor HAND2	HAND2	G
HMG-CoA lyase	HMGCL	E
HMG-CoA reductase	HMGCR	E
HMG-CoA synthase	HMGCS2	E
Hormone-sensitive lipase	HSL	E
HSSB, replication protein		E
Hypoxanthine-guanine phosphoribosyltransferase, HGPRT	HPRT	E
Ibonucleoside diphosphate reductase		E
Ikaros gene	IKAROS	G
Inosine monophosphate dehydrogenase, IMPDH		E
Inosine triphosphatase	ITPA	E

Inositol monophosphatase	IMPA1	N
Insulin	INS	G
Insulin receptor	INSR	G
Insulin-like growth factor 1 receptor	IGF1R	G
Insulin-like growth factor 2 receptor	IGF2R	G
Interferon alpha	IFNA1	I
Interferon beta	IFNB	I
Interferon gamma	IFNG	I
Interferon gamma receptor 1	IFNGR1	I
Interferon gamma receptor 2	IFNGR2	I
Interferon regulatory factor 1	IRF1	I
Interferon regulatory factor 4	IRF4	I
Interleukin(IL) 1 receptor	IL1R	I
Interleukin(IL) 1, alpha	IL1A	I
Interleukin(IL) 1, beta	IL1B	I
Interleukin(IL) 10	IL10	I
Interleukin(IL) 10 receptor	IL10R	I
Interleukin(IL) 11	IL11	I
Interleukin(IL) 11 receptor	IL11R	I
Interleukin(IL) 12	IL12	I
Interleukin(IL) 12 receptor, beta 1	IL12RB1	I
Interleukin(IL) 13	IL13	I
Interleukin(IL) 13 receptor	IL13R	I
Interleukin(IL) 2	IL2	I
Interleukin(IL) 2 receptor, alpha	IL2RA	I
Interleukin(IL) 2 receptor, gamma	IL2RG	I
Interleukin(IL) 3	IL3	I
Interleukin(IL) 3 receptor	IL3R	I
Interleukin(IL) 4	IL4	I
Interleukin(IL) 4 receptor	IL4R	I
Interleukin(IL) 5	IL5	I
Interleukin(IL) 5 receptor	IL5R	I
Interleukin(IL) 6	IL6	I
Interleukin(IL) 6 receptor	IL6R	I
Interleukin(IL) 7	IL7	I
Interleukin(IL) 7 receptor	IL7R	I
Interleukin(IL) 8	IL8	I
Interleukin(IL) 8 receptor	IL8R	I
Interleukin(IL) 9	IL9	I
Interleukin(IL) 9 receptor	IL9R	I
Interleukin(IL) receptor antagonist 1	IL1RN, IL1RA	I
Kallikrein 3	KAK3	I
Kinectin	KTN1	G
Kinesin, heavy chain	KNSL1	G
Kinesin, light chain	KNS2	G
Kininogen, High molecular weight	KNG	I
Leptin	LEP	G
Leptin receptor	LEPR	G

Leukotriene A4 hydrolase		I
Leukotriene B4 receptor		I
Leukotriene C4 receptor		I
Leukotriene D4/E4 receptor		I
LH/choriogonadotropin (CG) receptor	LHCGR	G
LIM homeobox transcription factor 1, beta	LMX1B	G
Lipoprotein lipase	LPL	I
Lipoprotein receptor, Low Density	LDLR	T
Lipoxygenase 12 (platelets)	LOG12	I
Lipoxygenase 5 (leukocytes)		I
Low density lipoprotein receptor-related protein precursor	LRP	T
Lysosomal acid lipase	LIPA	E
Malonyl CoA decarboxylase		E
Malonyl CoA transferase		E
Maltase-glucoamylase		E
Mannose binding protein	MBP	I
Mannosyl (alpha-1,6-)-glycoprotein beta-1, 2-	MGAT2	T
N-acetylglucosaminyltransferase		
MAPK kinase 1	MAPKK1; MEK1	G
MAPK kinase 4	MAPKK4; MEK4; SERK1	G
MAPK kinase 6	MAPKK6; MEK6	G
MAPKK kinase	MAPKKK	G
Matrix Gla protein	MGP	G
MEK kinase, MEKK		E
Melanocortin 2 receptor	MC2R	T
Melanocortin 4 receptor	MC4R	T
Methionine adenosyltransferase	MAT1A, MAT2A	E
Methionine synthase	MTR	E
Methionine synthase reductase	MTRR	E
Methylguanine-DNA methyltransferase	MGMT	E
Mevalonate kinase	MVK	E
MHC Class I: Tap1	ABCR, TAP1	I
MHC Class II: Tap2	TAP2, PSF2	I
Microphthalmia-associated transcription factor	MITF	G
Mismatch repair gene, PMSL1	PMS1	G
Mismatch repair gene, PMSL2	PMS2	G
Mitochondrial trifunctional protein, alpha subunit	HADHA	E
Mitochondrial trifunctional protein, beta subunit	HADHB	E
Mitogen-activated protein (MAP) kinase	MAPK	G
Monoamine oxidase A	MAOA	E
Monoamine oxidase B	MAOB	E
Multidrug resistance associated protein	MRP	G
Muscarinic receptor, M1	CHRM1	N
Muscarinic receptor, M2	CHRM2	N
Muscarinic receptor, M3	CHRM3	N

Muscarinic receptor, M4	CHRM4	N
Muscarinic receptor, M5	CHRM5	N
Na <sup>+</sup> , K <sup>+</sup> ATPase, alpha	ATP1A1	G
Na <sup>+</sup> , K <sup>+</sup> ATPase, beta 1	ATP1B1	G
Na <sup>+</sup> , K <sup>+</sup> ATPase, beta 2	ATP1B2	G
Na <sup>+</sup> , K <sup>+</sup> ATPase, beta 3	ATP1B3	G
Na <sup>+</sup> /H <sup>+</sup> exchanger 1	NHE1	T
Na <sup>+</sup> /H <sup>+</sup> exchanger 2	NHE2	T
Na <sup>+</sup> /H <sup>+</sup> exchanger 3	NHE3	T
Na <sup>+</sup> /H <sup>+</sup> exchanger 4	NHE4	T
Na <sup>+</sup> /H <sup>+</sup> exchanger 5	NHE5	T
N-acetylgalactosamine-6-sulfate sulfatase	GALNS	E
N-acetylglucosamine-6-sulfatase	GNS	E
N-acetylglucosaminidase, alpha	NAGLU	E
N-acetyltransferase 1	NAT1	E
N-acetyltransferase 2	NAT2	E
N-acyl hydrolase		I
NADH dehydrogenase (ubiquinone) flavoprotein 1	NDUFV1	E
NADH-cytochrome b5 reductase	DIA1	E
NADPH-dependent cytochrome P450 reductase	POR	E
Nephrolithiasis 2	NPHL2	T
Nephronophthisis 2	NPHP2	T
Nephrosis 1	NPHS1	T
Neuroendocrine convertase 1	NEC1, PCSK1	E
Neurokinin A	NKNA	N
Neurokinin B	NKNB	N
Neuropeptide Y	NPY	N
Neuropeptide Y receptor Y1	NPY1R	N
Neuropeptide Y receptor Y2	NPY2R	N
Niacin receptor		G
Niemann-Pick disease protein	NPC1	T
Nuclear factor kappa beta	NFKB	I
Nuclear factor of activated T cells (NFAT) complex, cytosolic	NFATC	G
Nuclear factor of activated T cells (NFAT) complex, preexisting component	NFATP	G
Nucleoside diphosphate kinase-A	NDPKA	E
Oncogene spi1		G
Opioid receptor, delta	OPRD1	N
Opioid receptor, kappa	OPRK1	N
Opioid receptor, mu	OPRM1	N
Ornithine transcarbamoylase	OTC, NME1	E
Osteoprotegerin	OPG	G
Otoferlin	OTOF	N
Oxytocin	OXT	N
Oxytocin receptor	OXTR	N

Paired-like homeodomain transcription factor 2	PITX2	G
Paired-like homeodomain transcription factor 3	PITX3	G
Paraoxonase PON1	PON1	E
Paraoxonase PON2	PON2	E
Paraoxonase PON3		E
Parathyroid hormone	PTH	G
Parathyroid hormone receptor	PTHr1	G
Parathyroid hormone related-peptide	PTHrP	G
Parathyroid hormone-like hormone	PTHrLH	G
Parvalbumin	PVALB	G
PCNA (proliferating cell nuclear antigen)		E
Peanut-like 1	PNUTL1	I
Peroxisomal membrane protein 1	PXMP1	S
Peroxisome biogenesis factor 1	PEX1	T
Peroxisome biogenesis factor 19	PEX19	T
Peroxisome biogenesis factor 6	PEX6	T
Peroxisome biogenesis factor 7	PEX7	T
Peroxisome proliferative activated receptor, alpha	PPARA	T
Peroxisome proliferative activated receptor, gamma	PPARG	T
P-glycoprotein 1	PGY1	T
P-glycoprotein 3	PGY3	T
Phenylethanolamine N-methyltransferase, PNMT	PNMT	E
Phosphodiesterase 1 / nucleotide pyrophosphatase 1	PDNP1	G
Phosphodiesterase 1 / nucleotide pyrophosphatase 2	PDNP2	G
Phosphodiesterase 1 / nucleotide pyrophosphatase 3	PDNP3	G
Phospholipase A2, group 10	PLA2G10	I
Phospholipase A2, group 1B	PLA2G1B	I
Phospholipase A2, group 2A	PLA2G2A	I
Phospholipase A2, group 2B	PLA2G2B	I
Phospholipase A2, group 4A	PLA2G4A	I
Phospholipase A2, group 4C	PLA2G4C	I
Phospholipase A2, group 5	PLA2G5	I
Phospholipase A2, group 6	PLA2G6	I
Phospholipase C alpha		I
Phospholipase C beta		I
Phospholipase C delta	PLCD1	I
Phospholipase C epsilon		I
Phospholipase C gamma	PLCG1	I
Phosphomannomutase-2	PMM2	T
Phosphomannose isomerase-1, PMI1	MPI	T
Phosphoribosyl pyrophosphate synthetase	PRPS1	E
Pituitary adenylate cyclase activating peptide	PACAP	N

Pituitary adenylate cyclase activating peptide receptor	PACAP1R	N
Plasminogen activator, Tissue	PLAT; TPA	E
Platelet-activating factor receptor	PAFR	I
Plectin 1	PLEC1	T
Polycystin 1	PKD1	T
Polycystin 2	PKD2	T
Porphobilinogen deaminase	HMBS	E
Potassium channel, calcium-activated,	KCNN4	N
Potassium channel, subfamily K, member 1	KCNK1	N
Potassium channel, subfamily K, member 2	KCNK2	N
Potassium channel, subfamily K, member 3	KCNK3	N
Potassium inwardly-rectifying channel J1	KCNJ1	N
Potassium inwardly-rectifying channel J11	KCNJ11	N
Potassium voltage-gated channel A1	KCNA1	N
Potassium voltage-gated channel E1	KCNE1	N
Potassium voltage-gated channel Q1	KCNQ1	N
Potassium voltage-gated channel Q2	KCNQ2	N
Potassium voltage-gated channel Q3	KCNQ3	N
POU domain, class 1, transcription factor 1 (Pit1)	POU1F1	G
POU domain, class 3, transcription factor 4	POU3F4	G
POU domain, class 4, transcription factor 3	POU4F3	G
Pre-B-cell leukemia transcription factor 1	PBX1	G
Preproglucagon	GCG;GLP1; GLP2	G
Progesterone receptor (RU486 binding receptor)	PGR	G
Prolactin	PRL	G
Prolactin receptor	PRLR	G
Proopiomelanocortin	POMC	N
Prostacyclin synthase		I
Prostaglandin 15-OH dehydrogenase	HGPD; PGDH	I
Prostaglandin D - DP receptor		I
Prostaglandin E1 receptor		I
Prostaglandin E2 receptor		I
Prostaglandin E3 receptor		I
Prostaglandin F - FP receptor		I
Prostaglandin F2 alpha receptor		I
Prostaglandin IP receptor		I
Prostaglandin-endoperoxidase synthase 2	PTGS2	G
Protease nexin 2	PN2	E
Protein C	PROC	I
Protein kinase DNA-activated	PRKDC	E
Protein S	PROS1	I
Pterin-4-alpha-carbinolamine	PCBD	
Purine nucleoside phosphorylase	NP	E
Purinergic receptor P1A1		N
Purinergic receptor P1A2		N

Purinergic receptor P1A3		N
Purinergic receptor P2X, 1	P2RX1	N
Purinergic receptor P2X, 2	P2RX2	N
Purinergic receptor P2X, 3	P2RX3	N
Purinergic receptor P2X, 4	P2RX4	N
Purinergic receptor P2X, 5	P2RX5	N
Purinergic receptor P2X, 6	P2RX6	N
Purinergic receptor P2X, 7	P2RX7	N
Purinergic receptor P2Y, 1	P2RY1	N
Purinergic receptor P2Y, 11	P2RY11	N
Purinergic receptor P2Y, 2	P2RY2	N
RAD51, DNA repair protein	RAD51	G
RAD52, DNA repair protein	RAD52	G
RAD54, DNA repair protein	RAD54	G
RAD55, DNA repair protein	RAD55	G
RAD57, DNA repair protein	RAD57	G
Recombination activating gene 1	RAG1	G
Recombination activating gene 2	RAG2	G
Red cone pigment	RCP	S
Replication factor A		E
Replication factor C	RFC2	E
Retinaldehyde binding protein 1	RLBP1	T
Retinoic acid receptor, alpha	RARA	G
Retinoic acid receptor, beta	RARB	G
Retinoic acid receptor, gamma	RARG	G
Retinoid X receptor, alpha	RXRA	G
Retinoid X receptor, beta	RXRB	G
Retinoid X receptor, gamma	RXRG	G
Retinol binding protein 1		T
Retinol binding protein 2		T
Retinol binding protein 4	RBP4	T
Ribonucleotide reductase, RRM		E
Ribosephosphate pyrophosphokinase		E
Ribosomal protein L13A	RPL13A	G
Ribosomal protein S19	RPS19	E
Ribosomal protein S4, X-linked	RPS4X	E
Ribosomal protein S6 kinase	RPS6KA3	E
Ribosomal protein S9	RPS9	G
S-adenosylmethionine decarboxylase, AMD		E
Secretin	SCT	T
Secretin receptor, SCTR	SCTR	T
Serine hydroxymethyltransferase	SHMT	E
Serotonin N-acetyltransferase	SNAT	E
Serotonin receptor, 5HT1A	HTR1A	N
Serotonin receptor, 5HT1B	HTR1B	N
Serotonin receptor, 5HT1C	HTR1C	N
Serotonin receptor, 5HT1D	HTR1D	N
Serotonin receptor, 5HT1E	HTR1E	N

Serotonin receptor, 5HT1F	HTR1F	N
Serotonin receptor, 5HT2A	HTR2A	N
Serotonin receptor, 5HT2B	HTR2B	N
Serotonin receptor, 5HT2C	HTR2C	N
Serotonin receptor, 5HT3	HTR3	N
Serotonin receptor, 5HT4	HTR4	N
Serotonin receptor, 5HT5	HTR5	N
Serotonin receptor, 5HT6	HTR6	N
Serotonin receptor, 5HT7	HTR7	N
Slug protein		G
Small nuclear ribonucleoprotein polypeptide N	SNRPN	S
Sodium channel, non-voltage gated 1, alpha	SCNN1A	N
Sodium channel, non-voltage gated 1, beta	SCNN1B	N
Sodium channel, non-voltage gated 1, gamma	SCNN1G	N
Sodium channel, voltage gated, type IV, alpha	SCN4A	N
polypeptide		
Sodium channel, voltage gated, type V, alpha	SCN5A	N
polypeptide		
Sodium channel, voltage-gated, type 1, beta	SCN1B	N
polypeptide		
Solute carrier family 1 (amino acid transporter), member 6	SLC1A6	T
Solute carrier family 1 (glial high affinity glutamate transporter), member 3	SLC1A3	T
Solute carrier family 1 (glutamate transporter), member 1	SLC1A1	T
Solute carrier family 1 (glutamate transporter), member 2	SLC1A2	T
Solute carrier family 1 (neutral amino acid transporter), member 4	SLC1A4	T
Solute carrier family 10 (sodium/bile acid cotransporter family), member 1	SLC10A1	T
Solute carrier family 10 (sodium/bile acid cotransporter family), member 2	SLC10A2	T
Solute carrier family 12, member 1	SLC12A1	T
Solute carrier family 12, member 2	SLC12A2	T
Solute carrier family 12, member 3	SLC12A3	T
Solute carrier family 14, member 2	SLC14A2	T
Solute carrier family 15 (H <sup>+</sup> /peptide transporter, intestinal), member 1	SLC15A1	T
Solute carrier family 15 (H <sup>+</sup> /peptide transporter, kidney), member 2	SLC15A2	T
Solute carrier family 16 (monocarboxylate transporter), member 1	SLC16A1	T
Solute carrier family 16 (monocarboxylate transporter), member 7	SLC16A7	T
Solute carrier family 17, member 1	SLC17A1	T
Solute carrier family 17, member 2	SLC17A2	T



Solute carrier family 18, member 3	SLC18A3	T
Solute carrier family 19 (folate transporter), member 1	SLC19A1	T
Solute carrier family 2 (facilitated glucose transporter), member 1	SLC2A1	T
Solute carrier family 2 (facilitated glucose transporter), member 2	SLC2A2	T
Solute carrier family 2 (facilitated glucose transporter), member 3	SLC2A3	T
Solute carrier family 2 (facilitated glucose transporter), member 4	SLC2A4	T
Solute carrier family 2 (facilitated glucose transporter), member 5	SLC2A5	T
Solute carrier family 20, member 1	SLC20A1	T
Solute carrier family 20, member 2	SLC20A2	T
Solute carrier family 20, member 3	SLC20A3	T
Solute carrier family 21, member 2	SLC21A2	T
Solute carrier family 21, member 3	SLC21A3	T
Solute carrier family 22, member 1	SLC22A1	T
Solute carrier family 22, member 2	SLC22A2	T
Solute carrier family 22, member 5	SLC22A5	T
Solute carrier family 25, member 12	SLC25A12	T
Solute carrier family 3 (facilitated glucose transporter), member 1	SLC3A1	T
Solute carrier family 4 (anion exchanger), member 1	SLC4A1	T
Solute carrier family 4 (anion exchanger), member 2	SLC4A2	T
Solute carrier family 4 (anion exchanger), member 3	SLC4A3	T
Solute carrier family 5 (sodium/glucose transporter), member 1	SLC5A1	T
Solute carrier family 5 (sodium/glucose transporter), member 2	SLC5A2	T
Solute carrier family 5 (sodium/glucose transporter), member 5	SLC5A5	T
Solute carrier family 5, member 3	SLC5A3	T
Solute carrier family 6 (GAMMA-AMINOBUTYRIC ACID transporter), member 1	SLC6A1	T
Solute carrier family 6 (neurotransmitter transporter, dopamine), member 3	SLC6A3	T
Solute carrier family 6 (neurotransmitter transporter, noradrenaline), member 2	SLC6A2	T
Solute carrier family 6 (neurotransmitter transporter, serotonin), member 4	SLC6A4	T
Solute carrier family 6, member 10	SLC6A10	T
Solute carrier family 6, member 6	SLC6A6	T
Solute carrier family 6, member 8	SLC6A8	T

Solute carrier family 7(amino acid transporter), member 1	SLC7A1	T
Solute carrier family 7(amino acid transporter), member 2	SLC7A2	T
Solute carrier family 7(amino acid transporter), member 7	SLC7A7	T
Solute carrier family 8 (sodium/calcium exchanger), member 1	SLC8A1	T
Somatostatin	SST	N
Somatostatin receptor, SSTR1	SSTR1	N
Somatostatin receptor, SSTR2	SSTR2	G
Somatostatin receptor, SSTR3	SSTR3	N
Somatostatin receptor, SSTR4	SSTR4	N
Somatostatin receptor, SSTR5	SSTR5	N
Sorcin	SRI	T
SOS1 guanine nucleotide exchange factor	SOS1	G
Steroid 5 alpha reductase 1	SRD5A1	E
Steroid 5 alpha reductase 2	SRD5A2	E
Steroid hormone receptor responsive DNA elements		G
Sterol carrier protein 2	SCP2	T
Succinic semi-aldehyde dehydrogenase	ssadh	E
Sucrase		E
Sulfonylurea receptor	SUR	G
Synaptic vesicle amine transporter	SVAT	N
Tachykinin receptor, NK1R	TACR1	N
Tachykinin receptor, NK2R	TACR2	N
Tachykinin receptor, NK3R	TACR3	N
Terminal deoxynucleotidyltransferase	TDT	I
Thiopurine S-methyltransferase	TPMT	E
Thrombopoietin	THPO	G
Thromboxane A synthase 1	TBXAS1	I
Thromboxane A2	TXA2	I
Thromboxane A2 receptor	TBXA2R	I
Thymidylate synthase	TYMS	E
Thymopoietin	TMPO	G
Thyroid hormone receptor, beta	THRB	G
Thyroid-stimulating hormone receptor	TSHR	G
Thyroid-stimulating hormone, alpha	TSHA	G
Thyroid-stimulating hormone, beta	TSHB	G
Topoisomerase I		E
Topoisomerase II		E
Transcription factor 1, hepatic	TCF1	G
Transcription factor 2, hepatic	TCF2	G
Transcription factor 3	TCF3	G
Transcription factor binding to IGHM enhancer 3	TFE3	G
Transcription factor, TUPLE1	TUPLE1	N

Transcription termination factor, RNA polymerase 1	TTF1	G
Transcription termination factor, RNA polymerase 2	TTF2	G
Transcription termination factor, RNA polymerase 3	TTF3	G
Transferrin	TF	G
Transferrin receptor	TFRC	G
Transthyretin	TTR	T
Tubulin		S
Tumour necrosis factor (TNF) receptor associated factor 1	TRAF1	I
Tumour necrosis factor (TNF) receptor associated factor 2	TRAF2	I
Tumour necrosis factor (TNF) receptor associated factor 3	TRAF3	I
Tumour necrosis factor (TNF) receptor associated factor 4	TRAF4	I
Tumour necrosis factor (TNF) receptor associated factor 5	TRAF5	I
Tumour necrosis factor (TNF) receptor associated factor 6	TRAF6	I
Tumour necrosis factor alpha	TNFA	I
Tumour necrosis factor alpha receptor	TNFAR	I
Tumour necrosis factor beta	TNFB	I
Tumour necrosis factor beta receptor	TNFBF	I
Tumour protein p53	TP53, P53	G
Tumour protein p63	TP63	G
Tumour suppressor gene DRA	DRA	I
Ubiquitin		G
Ubiquitin activating enzyme, E1		E
Ubiquitin B	UBB	G
Ubiquitin C	UBC	G
Ubiquitin carboxyl-terminal esterase L1	UCHL1	G
Ubiquitin protein ligase E3A	UBE3A	E
UDP-glucose pyrophosphorylase		E
UDP-glucuronosyltransferase 1	ugt1d, UGT1	E
UDP-glucuronosyltransferase 2	UGT2	E
Uncoupling protein 1		T
Uncoupling protein 3	UCP3	T
Uridine monophosphate kinase	UMPK	I
Uridine monophosphate synthetase	UMPS	I
Uridinediphosphate(UDP)-galactose-4-epimerase	GALE	E
Vimentin	VIM	I
Vitamin B12-binding (R) protein		G
Vitamin D receptor	VDR	G
Xanthine dehydrogenase	XDH	E

Xeroderma pigmentosum, complementation group A	XPA	E
Xeroderma pigmentosum, complementation group B	XPB	E
Xeroderma pigmentosum, complementation group C	XPC	E
Xeroderma pigmentosum, complementation group D		E
Xeroderma pigmentosum, complementation group E		E
Xeroderma pigmentosum, complementation group F	XPF	E
Xeroderma pigmentosum, complementation group G	ERCC5	E
X-ray repair gene	XRCC9	G
Xylitol dehydrogenase		E
YY1 transcription factor	YY1	G

In a second aspect.

## ONCOLOGY

The invention relates to a method of assessing the consequences, complications and the many symptoms arising as a result of developing a cancer.

Despite the fact that there are several hundred types of cancer, it is still possible to list certain general characteristics. Cancer is a cellular disorder in which cells lack the ability to grow in a controlled and organised manner. A cancer cell divides to form a growth, or tumour, that invades and destroys neighbouring healthy tissue. Tumour cells may metastasise, i.e. detach from the tumour and spread to several sites around the body. After travelling through the blood or lymph system, cancer cells are able to start proliferating to produce new tumours elsewhere. Cancers often reoccur after attempted removal of the primary tumour via this process. Malignant cancers, i.e. ones that metastasise, generally cause death of the patient, unless adequately treated. Cancer is a common disease, being the second largest cause of death after vascular disorders. Approximately 20 percent of the population of the United Kingdom will die of cancer. The most common cancers are lung, colon, breast and prostate cancers (Weatherall, Ledingham and Warrell, 1996).

The characteristic symptoms and signs of cancer are due to the local effects of the cancer tumour infiltrating surrounding healthy tissues and causing pressure and distortion of neighbouring structures. In addition to these local site-specific symptoms, tumours produce symptoms that are, to some extent common to all cancers. These include;

- Pain.
- Weight loss.
- Tumour mass.
- Fever.
- Anaemia.
- Hypercalcaemia.

Such symptoms lead to difficulties in the clinical care of patients, difficulties in the treatment and recovery of patients and lead to stress and anxiety in their carers and families.

### *Causes of Cancer:*

The causes of and molecular pathologies occurring in the processes leading to cancer are numerous and complicated. Identifying the molecular basis of cell transformation, i.e. the genetic changes that cause a normal cell or group of cells to lose sensitivity to the normal restraints on multiplication and thus become a tumour, has been the central issue of cancer research.

A key focus has been the mechanisms by which the loss of sensitivity to constraints on multiplication becomes a heritable and, most importantly, stable characteristic of cells and their daughter cells. Thus ensuring the development of a tumour which can continue to grow without responding to the increased cellular density and with 'no respect for the integrity of cellular architecture' (Harris 1996).

Two areas of research in the early 1980s resulted in a great step forward on the way to this objective. These were the studies of oncogenic retroviruses and of polypeptide growth factors. The simple genomes of type C retroviruses facilitated research into their mechanisms of transformation. It was found that oncogenic variants contained additional nucleic acid sequences very similar to expressed genes in mammalian cells. It rapidly became clear that these were acquired by recombination from host DNA and that their presence in the virus and their expression following infection were critical for transformation. This work on viral transformation thus identified a class of genes, now called oncogenes, present in human DNA and with the potential to transform cells when activated.

A second class of genes, tumour suppressor genes, has been identified with a different mode of action. Here inactivation of a normally active gene leads to tumour formation. Many cancers of this type have a homozygous recessive mechanism of inheritance (e.g. Wilms tumour, neurofibromatosis, familial adenomatous polyposis coli). As a result of these studies it is now appreciated that the genetic mechanism leading to tumour formation are complex and that several genetic steps might have to occur before transformation to a malignant cell phenotype is complete (Weatherall, Ledingham and Warrell, 1996).

In addition several environmental factors have a well documented carcinogenic potential such as ionizing radiation (e.g. X rays, sunshine), drugs (e.g. steroids, oestrogens, cyclosporin) and chemicals used in industry and manufacturing (e.g. aromatic amines, polycyclic hydrocarbons, vinyl chloride).

### *Treatment of Cancer:*

The unrestricted growth of a tumour causes damage to healthy tissues by occupying space (resulting in physical stresses to surrounding tissues) competing for oxygen and nutrients. From a healthcare management point of view, the most important clinical property of a tumour is its rate of growth and ability to generate secondary deposits of growth at distant sites in the body (metastasise). There is evidence that both of these factors can be related to the nature of the genetic changes within the cell and the degree of dedifferentiation expressed by the cell.

Management of cancer often involves more than one type of treatment and includes:

- Surgery
- Chemotherapy
- Radiotherapy

Local treatment frequently involves both surgery and radiotherapy in order to maximise the chances of local control.

The aim of surgical intervention is to completely excise the tumour with a margin of normal tissue around the main tumour mass. The risk of local reoccurrence is very high with a marginal excision. The aim of radiotherapy is to target the tumour mass accurately and deliver a high dose of radiation to that area in order to destroy all the tumour cells. Radiotherapy is of course toxic to normal tissue as well as malignant tissue which accounts for the side effects associated with the treatment.

Most tumours, for example breast tumours, present with locally advanced or metastatic disease, make local approaches such as surgery or radiotherapy unlikely to result in cure or long term remission. The role of these treatments therefore is primarily to prevent local reoccurrence rather than to be curative.

*A growing number of cancer types respond to treatment with combination chemotherapy. Tumours such as lymphomas and leukaemias are very sensitive to anti-cancer drugs such as vincristine or cisplatin and remission of some of these cancers have been achieved in this way. There has been less success with the common solid tumours, such as lung, breast or colorectal cancer (Brody, Larner and Minnerman, 1998).*

One of the difficulties in the clinical management of tumours is the cytotoxicity of many of the therapeutic agents. Severe side effects are not uncommon and include cardiac toxicity, renal impairment, pulmonary fibrosis and bone marrow suppression (British National Formulary 1998).

Further management problems arise from the specific complications which accompany the spread of metastases including spinal cord compression, carcinomatous 'meningitis', cerebral involvement, liver failure, pleural effusions, pericardial effusions and pain.

There is considerable variation in the rates of growth of the various tumours and cancers and in their propensity to metastasise. The factors are known to relate to the morphology and physiology of the original cell type and the genetic changes occurring within the transformed cell. The rates of tumour progression also vary from individual to individual and the precise factors which lie behind such individual variation are uncertain. To complicate matters there is also considerable individual

variation in the degree of toleration to the cytotoxic side effects of commonly used drugs and in the outcome of therapeutic interventions such as recovery from surgery, development of secondary infections and efficacy of pain management.

We have elaborated on the value and utility to be derived from the gathering together of the genes which form the core gene list for this particular Genostic system.

These genes are elaborated below:

#### KEY TO 'PROTEIN FUNCTION' COLUMN

E ENZYME  
T TRANSPORT & STORAGE  
S STRUCTURAL  
I IMMUNITY  
N NERVOUS TRANSMISSION  
G GROWTH & DIFFERENTIATION

ONCOLOGY GENE LIST	HUGO gene symbol	Protein function
Absent in melanoma 1 gene	AIM1	G
Actin, alpha, cardiac	ACTC	S
Actin, alpha, skeletal	ACTA1	S
Actin, alpha, smooth, aortic	ACTA2	S
Activin		G
Activin A receptor, type 2B	ACVR2B	G
Activin A receptor, type 2-like kinase 1	ACVRL1	G
Adenomatous polyposis coli tumour suppressor gene	APC	G
Adenosine deaminase	ADA	E
Adenosine receptor A1	ADORA1	N
Adenosine receptor A2A	ADORA2A	N
Adenosine receptor A2B	ADORA2B	N
Adenosine receptor A3	ADORA3	N
Adenyl cyclase		N
Adenylate cyclase 1	ADCY1	E
Adenylate cyclase 2	ADCY2	E
Adenylate cyclase 3	ADCY3	E
Adenylate cyclase 4	ADCY4	E
Adenylate cyclase 5	ADCY5	E
Adenylate cyclase 6	ADCY6	E
Adenylate cyclase 7	ADCY7	E
Adenylate cyclase 8	ADCY8	E
Adenylate cyclase 9	ADCY9	E
Adrenergic receptor, alpha1	ADRA1	N
Adrenergic receptor, alpha2	ADRA2	N
Adrenergic receptor, beta1	ADRB1	N
Adrenergic receptor, beta2	ADRB2	N
Adrenergic receptor, beta3	ADRB3	N



Adrenocorticotrophic hormone (ACTH) receptor	ACTHR	G
Albumin, ALB	ALB	T
Alcohol dehydrogenase 3	ADH3	E
Aldehyde dehydrogenase 1	ALDH1	E
Aldehyde dehydrogenase 10	ALDH10	E
Aldehyde dehydrogenase 2	ALDH2	E
Aldehyde dehydrogenase 5	ALDH5	E
Aldehyde dehydrogenase 6	ALDH6	E
Aldehyde dehydrogenase 7	ALDH7	E
Aldosterone receptor	MLR	G
alpha tectorin	TECTA	G
alpha1-antitrypsin	PI	E
alpha-actinin 2	ACTN2	G
alpha-actinin 3	ACTN3	G
Alpha-fetoprotein	AFP	G
alpha-synuclein	SNCA	N
Amphiregulin	AREG	G
Amyloid beta A4 precursor protein	APP	N
Amyloid beta A4 precursor-like protein	APLP	N
Androgen receptor	AR	G
Angiopoietin 1	ANGPT1	G
Angiopoietin 2	ANGPT2	G
Angiotensin converting enzyme	ACE, DCP1	E
Angiotensin receptor 1	AGTR1	T
Angiotensin receptor 2	AGTR2	T
Angiotensinogen	AGT	E
Annexin 1	ANX 1	I
Antidiuretic hormone receptor	ADHR	T
Antithrombin III	AT3	E
AP-2, alpha	TFAP2A	G
AP-2, beta	TFAP2B	G
AP-2, gamma	TFAP2C	G
Apaf-1		S
Apoptosis antigen 1	APT1	I
Apoptosis antigen ligand 1	APT1LG1	I
Apoptosis-inducing factor	AIF	I
Apurinic endonuclease	APE	E
Arginine vasopressin	AVP	N
Arginosuccinate synthetase	ASS	E
Aryl hydrocarbon receptor	AHR	T
Aryl hydrocarbon receptor nuclear translocator	ARNT	T
Asparagine synthetase	AS	E
Aspartate receptor		N
Ataxia telangiectasia complementation group D	ATD, ATDC	G
Ataxia telangiectasia gene, AT	ATM	G
ATP cobalamin adenosyltransferase		E
ATP sulphurylase	atpsk2	E

ATP-binding cassette transporter 7	ABC7	I
Atrial natriuretic peptide	ANP	G
Atrial natriuretic peptide receptor A	NPR1	G
Atrial natriuretic peptide receptor B	NPR2	G
Atrial natriuretic peptide receptor C	NPR3	G
Atrophin 1	DRPLA	G
Bagpipe homeobox, drosophila homolog of, 1	BAPX1	G
B-cell CLL/lymphoma 1	BCL1	I
B-cell CLL/lymphoma 10	BCL10	I
B-cell CLL/lymphoma 3	BCL3	I
B-cell CLL/lymphoma 4	BCL4	I
B-cell CLL/lymphoma 5	BCL5	I
B-cell CLL/lymphoma 6	BCL6	I
B-cell CLL/lymphoma 7	BCL7	I
B-cell CLL/lymphoma 8	BCL8	I
B-cell CLL/lymphoma 9	BCL9	I
BCL2-associated X protein	BAX	G
BCL2-related protein A1	BCL2A1	G
Beckwith-Wiedemann region 1A	BWR1A	G
Benzodiazepine receptor		N
beta 2 microglobulin	B2M	I
beta-endorphin receptor		N
beta-synuclein	SNCB	N
Bleomycin hydrolase	BLMH	E
Bone morphogenetic protein, BMP1	BMP1	G
Bone morphogenetic protein, BMP2	BMP2	G
Bone morphogenetic protein, BMP3	BMP3	G
Bone morphogenetic protein, BMP4	BMP4	G
Bone morphogenetic protein, BMP5	BMP5	G
Bone morphogenetic protein, BMP6	BMP6	G
Bone morphogenetic protein, BMP7	BMP7	G
Bone morphogenetic protein, BMP8	BMP8	G
Bradykinin receptor B1		I
Bradykinin receptor B2		I
Brain derived neurotrophic factor	BDNF	G
Brain derived neurotrophic factor (BDNF) receptor	BDNFR	G
Branched chain aminotransferase 1, cytosolic	BCAT1	E
Branched chain aminotransferase 2, mitochondrial	BCAT2	E
BRCA1-associated RING domain gene 1	BARD1	G
Breakpoint cluster region	BCR	G
Breast cancer 1	BRCA1	G
Breast cancer 2	BRCA2	G
Breast cancer, ductal, 1	BRCD1	G
Breast cancer, ductal, 2	BRCD2	G
Bruton agammaglobulinaemia tyrosine kinase	BTK	G
C1 inhibitor		E

Cadherin E	CDH1	G
Cadherin EP		G
Cadherin N	CDH2	G
Cadherin P	CDH3	G
Calbindin 1	CALB1	G
Calbindin D9K	CALB3	G
Calcitonin receptor /Calcitonin gene-related peptide receptor	CALCR	N
Calcitonin/Calcitonin gene-related peptide alpha	CALCA	N
Calcium channel, voltage-dependent, alpha 1F subunit	CACNA1F	N
Calcium channel, voltage-dependent, Alpha-1B (CACNL1A5)	CACNA1B	N
Calcium channel, voltage-dependent, Alpha-1C	CACNA1C	N
Calcium channel, voltage-dependent, Alpha-1D	CACNA1D	N
Calcium channel, voltage-dependent, Alpha-1E (CACNL1A6)	CACNA1E	N
Calcium channel, voltage-dependent, Alpha-2/delta	CACNA2	N
Calcium channel, voltage-dependent, Beta 1	CACNB1	N
Calcium channel, voltage-dependent, Beta 3	CACNB3	N
Calcium channel, voltage-dependent, L type, alpha 1S subunit	CACNA1S	N
Calcium channel, voltage-dependent, Neuronal, Gamma	CACNG2	N
Calcium channel, voltage-dependent, P/Q type, alpha 1A subunit	CACNA1A	N
Calcium channel, voltage-dependent, T-type		N
Calmodulin 1	CALM1	G
Calmodulin 2	CALM2	G
Calmodulin 3	CALM3	G
Calmodulin-dependant protein kinase II	CAMK2A	G
Calnexin	CANX	G
Carbonic anhydrase 3	CA3	E
Carbonic anhydrase 4	CA4	E
Carbonic anhydrase, alpha	CA1	E
Carbonic anhydrase, beta	CA2	E
Cardiac-specific homeobox, CSX	CSX	G
Cartilage-hair hypoplasia gene	CHH	N
Caspase 1	CASP1	G
Caspase 10	CASP10	G
Caspase 2	CASP2	G
Caspase 3	CASP3	G
Caspase 4	CASP4	G
Caspase 5	CASP5	G

Caspase 6	CASP6	G
Caspase 7	CASP7	G
Caspase 8	CASP8	G
Caspase 9	CASP9	G
Catenin, beta	CTNNB1	G
CD1	CD1	I
CD10	CD10	I
CD4	CD4	I
CEA		G
Cell adhesion molecule, intercellular, ICAM	ICAM1	G
Cell adhesion molecule, leukocyte-endothelial, LECAM (CD62)	LECAM1	G
Cell adhesion molecule, liver, LCAM	LCAM	G
Cell adhesion molecule, neural, NCAM1	NCAM1	G
Cell adhesion molecule, neural, NCAM120	NCAM120	G
Cell adhesion molecule, neural, NCAM2	NCAM2	G
Cell adhesion molecule, platelet-endothelial, PECAM	PECAM1	G
Cell adhesion molecule, vascular, VCAM	VCAM1	G
c-erbB1	ERBB1	G
c-erbB2	ERBB2	G
c-erbB3	ERBB3	G
c-erbB4	ERBB4	G
Ceruloplasmin precursor	CP	E
Chemokine receptor CXCR1	CXCR1	I
Chemokine receptor CXCR2	CXCR2	I
Cholecystokinin	CCK	N
Cholecystokinin B receptor	CCKBR	N
Ciliary neurotrophic factor (CNTF)	CNTF	G
Ciliary neurotrophic factor (CNTF) receptor	CNTFR	G
c-kit receptor tyrosine kinase		G
Clathrin		T
Clusterin	CLU	G
Collagen IV alpha 4	COL4A4	S
Collagen IV alpha 5	COL4A5	S
Collagen IV alpha 6	COL4A6	S
Colony-stimulating factor 1	CSF1	G
Colony-stimulating factor 1 receptor	CSF1R	G
Colony-stimulating factor 2	CSF2	G
Colony-stimulating factor 2 alpha receptor	CSF2RA	G
Colony-stimulating factor 2 beta receptor	CSF2RB	G
Colony-stimulating factor 3	CSF3	G
Colony-stimulating factor 3 receptor	CSF3R	G
Complement component C1 inhibitor	C1NH	I
Complement component C1qa	C1QA	I
Complement component C1qb	C1QB	I
Complement component C1qg	C1QG	I
Complement component C1r	C1R	I

Complement component C1s	C1S	I
Complement component C2	C2	I
Complement component C3	C3	I
Complement component C4A	C4A	I
Complement component C4B	C4B	I
Complement component C5	C5	I
Complement component C6	C6	I
Complement component C7	C7	I
Complement component C8	C8B	I
Complement component C9	C9	I
Complex III		E
Core-binding factor, alpha 1	CBFA1	G
Core-binding factor, alpha 2	CBFA2	G
Core-binding factor, beta	CBFB	G
Corticotrophin-releasing hormone	CRH	T
Corticotrophin-releasing hormone receptor	CRHR1	T
c-src tyrosine kinase	CSK	G
Cyclic AMP-dependent protein kinase	PKA	E
Cyclin A	CCNA	G
Cyclin B	CCNB	G
Cyclin C	CCNC	G
Cyclin D	CCND1	G
Cyclin E	CCNE	G
Cyclin F	CCNF	G
Cyclin-dependent kinase 1	CDK1	G
Cyclin-dependent kinase 10	CDK10	G
Cyclin-dependent kinase 2	CDK2	G
Cyclin-dependent kinase 3	CDK3	G
Cyclin-dependent kinase 4	CDK4	G
Cyclin-dependent kinase 5	CDK5	G
Cyclin-dependent kinase 6	CDK6	G
Cyclin-dependent kinase 7	CDK7	G
Cyclin-dependent kinase 8	CDK8	G
Cyclin-dependent kinase 9	CDK9	G
Cyclin-dependent kinase inhibitor 1A (P21, CIP1)	CDKN1A	G
Cyclin-dependent kinase inhibitor 1B (P27, KIP1)	CDKN1B	G
Cyclin-dependent kinase inhibitor 1C (P57, KIP2)	CDKN1C	G
Cyclin-dependent kinase inhibitor 2A (p16)	CDKN2A	G
Cyclin-dependent kinase inhibitor 3	CDKN3	G
Cyclooxygenase 1	COX1	E
Cyclooxygenase 2	COX2	E
CYP11A1	CYP11A1	E
CYP11B1	CYP11B1	E
CYP11B2	CYP11B2	E
CYP17	CYP17	E

CYP19	CYP19	E
CYP1A1	CYP1A1	E
CYP1A2	CYP1A2	E
CYP1B1	CYP1B1	E
CYP21	CYP21	E
CYP24	CYP24	E
CYP27	CYP27	E
CYP27B1	PDDR	E
CYP2A1	CYP2A1	E
CYP2A13	CYP2A13	E
CYP2A3	CYP2A3	E
CYP2A6V2	CYP2A6V2	E
CYP2A7	CYP2A7	E
CYP2B6	CYP2B6	E
CYP2C18	CYP2C18	E
CYP2C19	CYP2C19	E
CYP2C8	CYP2C8	E
CYP2C9	CYP2C9	E
CYP2D6	CYP2D6	E
CYP2E1	CYP2E1	E
CYP2F1	CYP2F1	E
CYP2J2	CYP2J2	E
CYP3A3	CYP3A3	E
CYP3A4	CYP3A4	E
CYP3A5	CYP3A5	E
CYP3A7	CYP3A7	E
CYP4A11	CYP4A11	E
CYP4B1	CYP4B1	E
CYP4F2	CYP4F2	E
CYP4F3	CYP4F3	E
CYP51	CYP51	E
CYP5A1	CYP5A1	E
CYP7A	CYP7A	E
CYP8	CYP8	E
Cystathionase	CTH	E
Cystathione beta synthase	CBS	E
Cystic fibrosis transmembrane conductance regulator, CFTR	CFTR	N
Cytidine deaminase	CDA	E
Cytidine-5-prime-triphosphate synthetase	CTPS	E
Cytochrome a		E
Cytochrome c		E
Cytochrome c oxidase, MTCO		E
Cytokine-suppressive antiinflammatory drug- binding protein 1	CSBP1	I
Cytokine-suppressive antiinflammatory drug- binding protein 2	CSBP2	I
Defender against cell death 1	DAD1	G

Deleted in colorectal carcinoma	DCC	G
Deleted in malignant brain tumours 1	DMBT1	G
Deoxycytidine kinase DCK		E
Deoxyuridine triphosphatase; dUTPase		E
Desert hedgehog, dhh		G
Dihydrofolate reductase	DHFR	E
Dihydrolipoyl dehydrogenase		E
Dihydropyrimidine dehydrogenase	DPYD	E
DM-Kinase	DMPK	E
DNA damage binding protein, DDB1	DDB1	S
DNA damage binding protein, DDB2	DDB2	S
DNA directed polymerase, alpha	POLA	E
DNA glycosylases		E
DNA helicases		E
DNA Ligase 1	LIG1	E
DNA methyltransferase	DNMT	E
DNA polymerase 1		E
DNA polymerase 2		E
DNA polymerase 3		E
DNA primase		E
DNA-damage-inducible transcript 3	DDIT3	S
DNA-dependant RNA polymerase		E
DOPA decarboxylase	DDC	E
Dopamine receptors D1	DRD1	N
Dopamine receptors D2	DRD2	N
Dopamine receptors D3	DRD3	N
Dopamine receptors D4	DRD4	N
Dopamine receptors D5	DRD5	N
Dynamin	DNM1	G
Dynorphin receptor		N
Dysferlin	DYS, DYSF	E
Dyskerin	DKC1	S
EB1		G
Endoglin	ENG	S
Endothelin 1	EDN1	N
Endothelin 2	EDN2	N
Endothelin 3	EDN3	N
Endothelin converting enzyme	ECE1	N
Endothelin receptor type A	EDNRA	N
Endothelin receptor type B	EDNRB	N
Enolase	ENO1	E
Ephrin receptor tyrosine kinase A	EPHA	G
Ephrin receptor tyrosine kinase B	EPHB	G
Epidermal growth factor	EGF	G
Epidermal growth factor receptor	EGFR	G
Estrogen receptor	ESR	G
Eukaryotic initiation translation factor	EIF4E	G
EWS RNA-binding protein	EWSR1	G

Excision repair complementation group 1 protein	ERCC1	E
Excision repair complementation group 2 protein	ERCC2	E
Excision repair complementation group 2 protein	ERCC3	E
Excision repair complementation group 4 protein	ERCC4	E
Excision repair complementation group 6 protein	ERCC6	E
Exostosin 1	EXT1	S
Exostosin 2	EXT2	S
FADH dehydrogenase		E
Fanconi anemia, complementation group C	FANCC	T
Fanconi anemia, complementation group D	FANCD	T
Fc fragment of IgG, high affinity IA, receptor for	FCGR1A	G
Fc fragment of IgG, low affinity IIa, receptor for	FCGR2A	G
(CD32)		
Fc fragment of IgG, low affinity IIIa, receptor for	FCGR3A	G
(CD16)		
Ferrochelatase	FECH	E
Fibrillin 1	FBN1	G
Fibroblast growth factor	FGF1	G
Fibroblast growth factor receptor 1	FGFR1	G
Fibroblast growth factor receptor 2	FGFR2	G
Fibroblast growth factor receptor 3	FGFR3	G
Fibronectin precursor	FN1	G
Folic acid receptor	FOLR	G
Follicle stimulating hormone receptor	FSHR, ODG1	G
Follicle stimulating hormone, FSH	FSHB	G
Follicular lymphoma variant translocation 1	FVT1	I
Forkhead rhabdomyosarcoma gene	FKHR	G
Forkhead transcription factor 14	FKHL14	G
Forkhead transcription factor 7	FKHL7	G
Fucosyltransferase 2	FUT2	T
Fucosyltransferase 3	FUT3	T
G/T mismatch binding protein	GTBP, MSH6	G
GABA receptor, alpha 1	GABRA1	N
GABA receptor, alpha 2	GABRA2	N
GABA receptor, alpha 3	GABRA3	N
GABA receptor, alpha 4	GABRA4	N
GABA receptor, alpha 5	GABRA5	N
GABA receptor, alpha 6	GABRA6	N
GABA receptor, beta 1	GABRB1	N
GABA receptor, beta 2	GABRB2	N
GABA receptor, beta 3	GABRB3	N
GABA receptor, gamma 1	GABRG1	N
GABA receptor, gamma 2	GABRG2	N



GABA receptor, gamma 3	GABRG3	N
Gadd45 (growth arrest & DNA-damage-inducible protein)		E
Galactosyltransferase 1	GT1	G
Galactosyltransferase, alpha 1,3	GGTA1	G
Galactosyltransferase, beta 3	B3GALT	G
Gastrin	GAS	G
Gastrin releasing peptide	GRP	T
Glioma chloride ion channel, GCC		G
Glucagon receptor	GCGR	G
Glucagon synthase		T
Glucocorticoid receptor	GRL	G
Glutamate receptor 1	GLUR1	N
Glutamate receptor 2	GLUR2	N
Glutamate receptor 3	GLUR3	N
Glutamate receptor 4	GLUR4	N
Glutamate receptor 5	GLUR5	N
Glutamate receptor 6	GLUR6	N
Glutamate receptor 7	GLUR7	N
Glutamate receptor, ionotropic, NMDA 1	NMDAR1	N
Glutamate receptor, ionotropic, NMDA 2A	NMDAR2A	N
Glutamate receptor, ionotropic, NMDA 2B	NMDAR2B	N
Glutamate receptor, ionotropic, NMDA 2C	NMDAR2C	N
Glutamate receptor, ionotropic, NMDA 2D	NMDAR2D	N
Glutathione	GSH	T
Glutathione S-transferase mu 1, GSTM1	GSTM1	E
Glutathione S-transferase theta 1, GSTT1	GSTT1	E
Glutathione S-transferase, GSTZ1	GSTZ1	E
Glyceraldehyde-3-phosphate dehydrogenase, GAPDH	GAPDH	E
Glycerol kinase	GK	E
Glycinamide ribonucleotide (GAR) transformylase	GART	E
Glycine receptor, alpha	GLRA2	N
Glycine receptor, beta		N
Glycine transporter	GLYT	N
Glypican 3	GPC3, SDYS	G
Gonadotropin releasing hormone	GNRH	G
Gonadotropin releasing hormone receptor	GNRHR	G
Growth factor receptor-bound protein 2	GRB2	G
Growth hormone 1	GH1	G
Growth hormone 2 (placental)	GH2	G
Growth hormone receptor	GHR	G
Growth hormone releasing hormone (GHRH)	GHRH	G
Growth hormone releasing hormone receptor	GHRHR	G
Growth/differentiation factor 5	GDF5	G
Growth-regulated protein precursor, GRO	GRO	I
GTPase-activating protein, GAP	RASA1	G
Guanine nucleotide-binding protein, alpha	GNAI1	N

inhibiting activity polypeptide 1, GNAI1		
Guanine nucleotide-binding protein, alpha	GNAI2	N
inhibiting activity polypeptide 2, GNAI2		
Guanine nucleotide-binding protein, alpha	GNAI3	N
inhibiting activity polypeptide 3, GNAI3		
Guanine nucleotide-binding protein, alpha	GNAS1	N
stimulating activity polypeptide, GNAS1		
Guanine nucleotide-binding protein, alpha	GNAS2	N
stimulating activity polypeptide, GNAS2		
Guanine nucleotide-binding protein, alpha	GNAS3	N
stimulating activity polypeptide, GNAS3		
Guanine nucleotide-binding protein, alpha	GNAS4	N
stimulating activity polypeptide, GNAS4		
Guanine nucleotide-binding protein, q	GNAQ	N
polypeptide		
Guanylate kinase		E
H(+), K(+) - ATPase	ATP4B	N
Hairless	HR	G
Hela tumor suppression gene	HTS1	G
Heparin binding epidermal growth factor	HBEGF	G
Hepatitis B virus integration site 1	HVBS1	I
Hepatitis B virus integration site 2	HVBS6	I
High mobility group protein C	HMGIC	G
High mobility group protein Y	HMG1Y	G
Histamine receptors, H1		N
Histamine receptors, H2		N
Histamine receptors, H3		N
HLH transcription factor HAND1	HAND1	G
HLH transcription factor HAND2	HAND2	G
HMG-CoA reductase	HMGCR	E
HMG-CoA synthase	HMGCS2	E
Homeobox (HOX) gene A13	HOXA13	G
Homeobox 11	HOX11	G
Homeobox HB24	HLX1	G
Homogentisate 1,2 dioxygenase	HGD	E
Hormone-sensitive lipase	HSL	E
HSSB, replication protein		E
Human placental lactogen	CSH1	G
Ibonucleoside diphosphate reductase		E
Ikaros gene	IKAROS	G
Inhibin, alpha	INHA	G
Inhibin, beta A	INHBA	G
Inhibin, beta B	INHBB	G
Inhibin, beta C	INHBC	G
Inositol 1,4,5-triphosphate receptor 3	ITPR3	G
Insulin	INS	G
Insulin receptor	INSR	G
Insulin-like growth factor 1	IGF1	G

Insulin-like growth factor 1 receptor	IGF1R	G
Insulin-like growth factor 2	IGF2	G
Insulin-like growth factor 2 receptor	IGF2R	G
Integrin beta 1	ITGB1	G
Integrin beta 2	ITGB2	G
Integrin beta 3	ITGB3	G
Integrin beta 4	ITGB4	G
Integrin beta 5	ITGB5	G
Integrin beta 6	ITGB6	G
Integrin beta 7	ITGB7	G
Integrin, alpha 1	ITGA1	G
Integrin, alpha 2	ITGA2	G
Integrin, alpha 4	ITGA4	G
Integrin, alpha 5	ITGA5	G
Integrin, alpha 6	ITGA6	G
Integrin, alpha M	ITGAM	G
Interferon alpha	IFNA1	I
Interferon beta	IFNB	I
Interferon gamma	IFNG	I
Interferon gamma receptor 1	IFNGR1	I
Interferon gamma receptor 2	IFNGR2	I
Interferon regulatory factor 1	IRF1	I
Interferon regulatory factor 4	IRF4	I
Interleukin(IL) 1 receptor	IL1R	I
Interleukin(IL) 1, alpha	IL1A	I
Interleukin(IL) 1, beta	IL1B	I
Interleukin(IL) 10	IL10	I
Interleukin(IL) 10 receptor	IL10R	I
Interleukin(IL) 11	IL11	I
Interleukin(IL) 11 receptor	IL11R	I
Interleukin(IL) 12	IL12	I
Interleukin(IL) 12 receptor, beta 1	IL12RB1	I
Interleukin(IL) 13	IL13	I
Interleukin(IL) 13 receptor	IL13R	I
Interleukin(IL) 2	IL2	I
Interleukin(IL) 2 receptor, alpha	IL2RA	I
Interleukin(IL) 2 receptor, gamma	IL2RG	I
Interleukin(IL) 3	IL3	I
Interleukin(IL) 3 receptor	IL3R	I
Interleukin(IL) 4	IL4	I
Interleukin(IL) 4 receptor	IL4R	I
Interleukin(IL) 5	IL5	I
Interleukin(IL) 5 receptor	IL5R	I
Interleukin(IL) 6	IL6	I
Interleukin(IL) 6 receptor	IL6R	I
Interleukin(IL) 7	IL7	I
Interleukin(IL) 7 receptor	IL7R	I
Interleukin(IL) 8	IL8	I

Interleukin(IL) 8 receptor	IL8R	I
Interleukin(IL) 9	IL9	I
Interleukin(IL) 9 receptor	IL9R	I
Interleukin(IL) receptor antagonist 1	IL1RN, IL1RA	I
Janus kinase 1	JAK1	G
Janus kinase 2	JAK2	G
Janus kinase 3	JAK3	G
Laminin 5, alpha 3	LAMA3	G
Laminin 5, beta 3	LAMB3	G
Laminin 5, gamma 2	LAMC2	G
Laminin M	LAMM	G
Laminin receptor 1	LAMR1	G
Latent transforming growth factor-beta binding protein 2	LTBP2	G
Leptin	LEP	G
Leptin receptor	LEPR	G
Leukaemia inhibitory factor	LIF	G
Leukaemia inhibitory factor receptor	LIFR	G
Leukotriene A4 hydrolase		I
Leukotriene B4 receptor		I
Leukotriene C4 receptor		I
Leukotriene D4/E4 receptor		I
LH/choriogonadotropin (CG) receptor	LHCGR	G
LIM homeobox protein 1	LHX1	G
LIM homeobox protein 2	LHX2	G
LIM homeobox protein 3	LHX3	G
LIM homeobox protein 4	LHX4	G
Limbic associated membrane protein	LAMP	G
LIM-domain only protein 1	LMO1	G
LIM-domain only protein 2	LMO2	G
LIM-domain only protein 3	LMO3	G
LIM-domain only protein 4	LMO4	G
Lipoma-preferred partner gene	LPP	G
Lipoxygenase 12 (platelets)	LOG12	I
Lipoxygenase 5 (leukocytes)		I
Long QT-type 2 potassium channels	LQT2, KCNH2	T
Lowe oculocerbrorenal syndrome gene	OCRL	E
Luteinizing hormone-releasing hormone		N
Luteinizing hormone-releasing hormone receptor		N
Lymphoblastic leukemia derived sequence 1	LYL1	I
Lymphocyte-specific protein tyrosine kinase	LCK	I
Lymphoid enhancer-binding factor	LEF-1	G
Macrophage activating factor	MAF	I
MAD (mothers against decapentaplegic, Drosophila) homologue 3	MADH3	G
MAD (mothers against decapentaplegic, Drosophila) homologue 4	MADH4	G

MADS box transcription-enhancer factor 2A	MEF2A	G
MADS box transcription-enhancer factor 2B	MEF2B	G
MADS box transcription-enhancer factor 2C	MEF2C	G
MADS box transcription-enhancer factor 2D	MEF2D	G
Malignant proliferation, eosinophil gene	MPE	I
MAPK kinase 1	MAPKK1; MEK1	G
MAPK kinase 4	MAPKK4; MEK4; SERK1	G
MAPK kinase 6	MAPKK6; MEK6	G
MAPKK kinase	MAPKKK	G
MAX-interacting protein 1	MXI1	G
MEK kinase, MEKK		E
Melanocortin 1 receptor	MC1R	T
Menin	MEN1	G
Methionine adenosyltransferase	MAT1A, MAT2A	E
Methionine synthase	MTR	E
Methionine synthase reductase	MTRR	E
Methylguanine-DNA methyltransferase	MGMT	E
MHC Class I: A		I
MHC Class I: B		I
MHC Class I: C		I
MHC Class I: LMP-2, LMP-7		I
MHC Class I: Tap1	ABCR, TAP1	I
MHC Class II: DP	HLA-DPB1	I
MHC Class II: DQ		I
MHC Class II: DR		I
MHC Class II: Tap2	TAP2, PSF2	I
MHC Class II:Complementation group A	MHC2TA	I
MHC Class II:Complementation group B	rfxank	I
MHC Class II:Complementation group C	RFX5	I
MHC Class II:Complementation group D	RFXAP	I
Midline 1	MID1	G
Mismatch repair gene, PMSL1	PMS1	G
Mismatch repair gene, PMSL2	PMS2	G
Mitogen-activated protein (MAP) kinase	MAPK	G
Motilin	MLN	G
Msh homeobox homolog 1	MSX1	G
Msh homeobox homolog 2	MSX2	G
Mucin 18	MUC18	T
Muscarinic receptor, M1	CHRM1	N
Muscarinic receptor, M2	CHRM2	N
Muscarinic receptor, M3	CHRM3	N
Muscarinic receptor, M4	CHRM4	N
Muscarinic receptor, M5	CHRM5	N
Mutated in colorectal cancers, MCC	MCC	G
MutL homolog 1	MLH1	G
MutS homolog 2	MSH2	G
MutS homolog 3	MSH3	G

Myelin protein peripheral 22	PMP22	S
Myelodysplasia syndrome 1 gene	MDS1	G
Myeloid leukemia factor-1	MLF1	I
N-acetyltransferase 1	NAT1	E
N-acetyltransferase 2	NAT2	E
NADPH-dependent cytochrome P450 reductase	POR	E
Nerve growth factor	NGF	G
Nerve growth factor receptor	NGFR	G
Neuregulin	HGL	G
Neurexin		N
Neurofibromin 1	NF1	G
Neurofibromin 2	NF2	G
Neurokinin A	NKNA	N
Neurokinin B	NKNB	N
Neuronal apoptosis inhibitory protein	NAIP	I
Neuropeptide Y	NPY	N
Neuropeptide Y receptor Y1	NPY1R	N
Neuropeptide Y receptor Y2	NPY2R	N
Neurotensin	NTS	N
Neurotensin receptor	NTSR1	N
Neurotrophic tyrosine kinase receptor 1	NTRK1	G
Neutral endopeptidase		E
Niacin receptor		G
Nodal	NODAL	G
Norrie disease protein	NDP	G
Notch 3	NOTCH3	G
Notch ligand - jagged 1	JAG1, AGS	G
Nuclear factor kappa beta	NFKB	I
Nuclear factor of activated T cells (NFAT) complex, cytosolic	NFATC	G
Nuclear factor of activated T cells (NFAT) complex, preexisting component	NFATP	G
Nuclear mitotic apparatus protein 1	NUMA1	G
Nucleophosmin	NPM1	T
Oligophrenin-1	OPHN1	G
Oncogene abl1	ABL1	G
Oncogene abl2		G
Oncogene akt1		G
Oncogene akt2	AKT2	G
Oncogene axl	AXL	G
Oncogene bcl2		G
Oncogene bcr/abl		G
Oncogene B-lym		G
Oncogene B-raf		G
Oncogene clk1		G
Oncogene c-myc		G
Oncogene cot		G

Oncogene crk		G
Oncogene crkl		G
Oncogene ect2		G
Oncogene ELK1	ELK1	G
Oncogene ELK2	ELK2	G
Oncogene ems1		G
Oncogene ERB		G
Oncogene ERB2		G
Oncogene ERBA		G
Oncogene ERBAL2		G
Oncogene ERG (early reponse gene)		G
Oncogene ETS1		G
Oncogene ETS2		G
Oncogene EVI1	EVI1	G
Oncogene fes		G
Oncogene fgr		G
Oncogene fos	FOS	G
Oncogene fps		G
Oncogene GLI1	GLI	G
Oncogene GLI2	GLI2	G
Oncogene GLI3	GLI3	G
Oncogene gro1		G
Oncogene gro2		G
Oncogene Ha-ras	HRAS	G
Oncogene hs1		G
Oncogene hst	FGF4	G
Oncogene int1	WNT1	G
Oncogene int2	FGF3	G
Oncogene int3	Notch4	G
Oncogene int4	WNT3	G
Oncogene jun	JUN	G
Oncogene KIT	KIT, PBT	G
Oncogene LCO	LCO	G
Oncogene l-myc		G
Oncogene lpsa		G
Oncogene lyn		G
Oncogene maf		G
Oncogene mas1		G
Oncogene mcf2		G
Oncogene mdm2	MDM2	G
Oncogene mel		G
Oncogene met	MET	G
Oncogene mos		G
Oncogene mpl		G
Oncogene MUM1	MUM1	G
Oncogene myb	MYB	G
Oncogene myc	MYC	G
Oncogene n-myc		G

Oncogene N-ras (neuroblastoma v-ras)	NRAS	G
Oncogene ovc		G
Oncogene pim1		G
Oncogene pti-1sea		G
Oncogene pvt1		G
Oncogene raf	RAF	G
Oncogene ralb		G
Oncogene rel		G
Oncogene ret	RET	G
Oncogene r-myc		G
Oncogene ros		G
Oncogene R-ras		G
Oncogene sis	PDGFB	G
Oncogene ski		G
Oncogene sno		G
Oncogene spi1		G
Oncogene src		G
Oncogene tc21		G
Oncogene TEL	ETV6	G
Oncogene tim		G
Oncogene vavtrk		G
Oncogene v-Ki-ras2	KRAS2	G
Oncogene yes		G
Oncogene yuasa		G
Oncostatin M	OSM	G
Oncostatin M receptor	OSMR	G
Opioid receptor, delta	OPRD1	N
Opioid receptor, kappa	OPRK1	N
Opioid receptor, mu	OPRM1	N
Orexin	OX	G
Osteopontin	OPN	G
Oxytocin	OXT	N
Oxytocin receptor	OXTR	N
Paired box homeotic gene 3	PAX3	G
Paired box homeotic gene 6	PAX6	G
Paired box homeotic gene 7	PAX7	G
Paired-like homeodomain transcription factor 2	PITX2	G
Paired-like homeodomain transcription factor 3	PITX3	G
Parathyroid hormone	PTH	G
Parathyroid hormone receptor	PTHr1	G
Parathyroid hormone related-peptide	PTHrP	G
Parvalbumin	PVALB	G
Patched (Drosophila) homolog, PTCH	PTCH	G
PCNA (proliferating cell nuclear antigen)		E
Peanut-like 1	PNUTL1	I
Peroxisome proliferative activated receptor, alpha	PPARA	T
Peroxisome proliferative activated receptor,	PPARG	T



gamma		
P-glycoprotein 1	PGY1	T
P-glycoprotein 3	PGY3	T
Phenylalanine hydroxylase	PAH	E
Phosphatase & tensin homolog	PTEN	G
Phosphatidylinositol glycan, class A (paroxysmal nocturnal hemoglobinuria)	PIGA	G
Phospholipase A2, group 10	PLA2G10	I
Phospholipase A2, group 1B	PLA2G1B	I
Phospholipase A2, group 2A	PLA2G2A	I
Phospholipase A2, group 2B	PLA2G2B	I
Phospholipase A2, group 4A	PLA2G4A	I
Phospholipase A2, group 4C	PLA2G4C	I
Phospholipase A2, group 5	PLA2G5	I
Phospholipase A2, group 6	PLA2G6	I
Phospholipase C epsilon		I
Phosphomannomutase 1	PMM1	G
Phosphomannomutase 2	PMM2	G
Plasminogen	PLG	E
Plasminogen activator inhibitor 1	PAI1	E
Plasminogen activator inhibitor 2	PAI2	E
Plasminogen activator receptor, Urokinase	UPAR; PLAUR	S
Plasminogen activator, Tissue	PLAT; TPA	E
Plasminogen activator, Urokinase	UPA; PLAU	E
Platelet derived growth factor	PDGF	G
Platelet derived growth factor receptor	PDGFR	G
Platelet glycoprotein 1b, beta	GP1BB	I
Platelet glycoprotein 1b, gamma	GP1BG	I
Platelet glycoprotein IX	GP9	I
Platelet glycoprotein V	GP5	I
Potassium inwardly-rectifying channel J1	KCNJ1	N
Potassium inwardly-rectifying channel J11	KCNJ11	N
Potassium voltage-gated channel A1	KCNA1	N
Potassium voltage-gated channel E1	KCNE1	N
Potassium voltage-gated channel Q1	KCNQ1	N
Potassium voltage-gated channel Q2	KCNQ2	N
Potassium voltage-gated channel Q3	KCNQ3	N
POU domain, class 1, transcription factor 1 (Pit1)	POU1F1	G
POU domain, class 3, transcription factor 4	POU3F4	G
POU domain, class 4, transcription factor 3	POU4F3	G
Pre-B-cell leukemia transcription factor 1	PBX1	G
Preproglucagon	GCG;GLP1; GLP2	G
Preproglucagon		T
Prion protein	PRNP	N
Prodynorphin		N
Progesterone receptor (RU486 binding receptor)	PGR	G

Prohibitin	PHB	G
Prolactin	PRL	G
Prolactin receptor	PRLR	G
Prolactin releasing hormone	PRH	G
Proliferin	PLF	G
Promyelocytic leukemia gene	PML	G
Proopiomelanocortin	POMC	N
Prophet of Pit1	PROP1	G
Prostacyclin synthase		I
Prostaglandin 15-OH dehydrogenase	HGPD; PGDH	I
Prostaglandin D - DP receptor		I
Prostaglandin E1 receptor		I
Prostaglandin E2 receptor		I
Prostaglandin E3 receptor		I
Prostaglandin F - FP receptor		I
Prostaglandin IP receptor		I
Prostate cancer anti-metastasis gene KAI1	KAI1	G
Protein kinase B	PRKB	
Protein kinase C, alpha	PRKCA	E
Protein phosphatase 2, regulatory subunit A, beta isoform	PPP2R1B	E
Protein tyrosine phosphatase, non-receptor type 12	PTPN12	G
Purine nucleoside phosphorylase	NP	E
Purinergic receptor P1A1		N
Purinergic receptor P1A2		N
Purinergic receptor P1A3		N
Purinergic receptor P2X, 1	P2RX1	N
Purinergic receptor P2X, 2	P2RX2	N
Purinergic receptor P2X, 3	P2RX3	N
Purinergic receptor P2X, 4	P2RX4	N
Purinergic receptor P2X, 5	P2RX5	N
Purinergic receptor P2X, 6	P2RX6	N
Purinergic receptor P2X, 7	P2RX7	N
Purinergic receptor P2Y, 1	P2RY1	N
Purinergic receptor P2Y, 11	P2RY11	N
Purinergic receptor P2Y, 2	P2RY2	N
Rabphilin		N
RAD51, DNA repair protein	RAD51	G
RAD52, DNA repair protein	RAD52	G
RAD54, DNA repair protein	RAD54	G
RAD55, DNA repair protein	RAD55	G
RAD57, DNA repair protein	RAD57	G
RAS-associated protein, RAB3A	RAB3A	N
Ras-G-protein	RAS	G
Receptor tyrosine kinase (RTK), Nsk2	NSK2	G
Relaxin H1	RLN1	G
Relaxin H2	RLN2	G

Replication factor A		E
Replication factor C	RFC2	E
Retinoblastoma 1	RB1	G
Retinoic acid receptor, alpha	RARA	G
Retinoic acid receptor, beta	RARB	G
Retinoic acid receptor, gamma	RARG	G
Retinoschisis, X-linked, juvenile	RS	G
Rhabdoid tumors	SMARCB1	G
Ribonucleotide reductase, RRM		E
Ribosomal protein L13A	RPL13A	G
Ribosomal protein L17	RPL17	G
Ribosomal protein S6 kinase	RPS6KA3	E
RIGUI	RIGUI	G
Rim		N
Ryanodine receptor 1, skeletal	RYR1	G
S-adenosylmethionine decarboxylase, AMD		E
SAP (SLAM-associated protein)	SH2D1A	I
Secretin	SCT	T
Secretin receptor, SCTR	SCTR	T
Serine hydroxymethyltransferase	SHMT	E
Serine/threonine kinase 11	STK11	G
Serine/threonine kinase 2	STK2	G
Serotonin receptor, 5HT1A	HTR1A	N
Serotonin receptor, 5HT1B	HTR1B	N
Serotonin receptor, 5HT1C	HTR1C	N
Serotonin receptor, 5HT1D	HTR1D	N
Serotonin receptor, 5HT1E	HTR1E	N
Serotonin receptor, 5HT1F	HTR1F	N
Serotonin receptor, 5HT2A	HTR2A	N
Serotonin receptor, 5HT2B	HTR2B	N
Serotonin receptor, 5HT2C	HTR2C	N
Serotonin receptor, 5HT3	HTR3	N
Serotonin receptor, 5HT4	HTR4	N
Serotonin receptor, 5HT5	HTR5	N
Serotonin receptor, 5HT6	HTR6	N
Serotonin receptor, 5HT7	HTR7	N
Signal transducer and activator of transcription 1	STAT1	G
Signal transducer and activator of transcription 2	STAT2	G
Signal transducer and activator of transcription 3	STAT3	G
Signal transducer and activator of transcription 4	STAT4	G
Signal transducer and activator of transcription 5	STAT5	G
Signaling lymphocyte activation molecule	SLAM	I
Sine oculis homeobox, drosophila, homolog 1	SIX1	G

Sine oculis homeobox, drosophila, homolog 2	SIX2	G
Sine oculis homeobox, drosophila, homolog 5	SIX5	G
Small nuclear ribonucleoprotein polypeptide N	SNRPN	S
Smoothed (Drosophila) homolog	SMOH	G
Sodium channel, non-voltage gated 1, alpha	SCNN1A	N
Sodium channel, non-voltage gated 1, beta	SCNN1B	N
Sodium channel, non-voltage gated 1, gamma	SCNN1G	N
Sodium channel, voltage gated, type V, alpha polypeptide	SCN5A	N
Sodium channel, voltage-gated, type 1, beta polypeptide	SCN1B	N
Solute carrier family 1 (glutamate transporter), member 1	SLC1A1	T
Solute carrier family 1 (glutamate transporter), member 2	SLC1A2	T
Solute carrier family 12, member 1	SLC12A1	T
Solute carrier family 12, member 2	SLC12A2	T
Solute carrier family 12, member 3	SLC12A3	T
Solute carrier family 19 (folate transporter), member 1	SLC19A1	T
Solute carrier family 25, member 12	SLC25A12	T
Solute carrier family 5 (sodium/glucose transporter), member 1	SLC5A1	T
Solute carrier family 5 (sodium/glucose transporter), member 2	SLC5A2	T
Solute carrier family 5 (sodium/glucose transporter), member 5	SLC5A5	T
Solute carrier family 5, member 3	SLC5A3	T
Solute carrier family 6 (GAMMA-AMINOBUTYRIC ACID transporter), member 1	SLC6A1	T
Solute carrier family 6 (neurotransmitter transporter, dopamine), member 3	SLC6A3	T
Solute carrier family 6 (neurotransmitter transporter, noradrenaline), member 2	SLC6A2	T
Solute carrier family 6 (neurotransmitter transporter, serotonin), member 4	SLC6A4	T
Somatostatin	SST	N
Somatostatin receptor, SSTR1	SSTR1	N
Somatostatin receptor, SSTR2	SSTR2	G
Somatostatin receptor, SSTR3	SSTR3	N
Somatostatin receptor, SSTR4	SSTR4	N
Somatostatin receptor, SSTR5	SSTR5	N
Sorcin	SRI	T
SOS1 guanine nucleotide exchange factor	SOS1	G
SRX-box 11	SOX11	G
Stem cell factor	SCF	G
Steroid hormone receptor responsive DNA elements		G

Steroidogenic acute regulatory protein	STAR	T
Substance P		N
Sulfonylurea receptor	SUR	G
Suppression of tumorigenicity 3 gene	ST3	G
Suppression of tumorigenicity 8 gene	ST8	G
Surfeit 1	SURF1	G
Synapsin 1a & 1b	SYN1	N
Synapsin 2a & 2b	SYN2	N
Synaptic vesicle protein 2	SV2	N
Synaptobrevin 1	SYB1	N
Synaptobrevin 2	SYB2	N
Synaptogyrin		N
Synaptophysin	SYP	N
Synaptosomal-associated protein, 25KD	SNAP25	N
Synaptotagmin 1	SYT1	N
Synaptotagmin 2	SYT2	N
Syndecan 1	SYND1	G
Syndecan 2	SYND2	G
Syndecan 3	SYND3	G
Syndecan 4	SYND4	G
Synovial sarcoma gene 1	SSX1	G
Synovial sarcoma gene 2	SSX2	G
Syntaxin 1	STX1	N
Tachykinin receptor, NK1R	TACR1	N
Tachykinin receptor, NK2R	TACR2	N
Tachykinin receptor, NK3R	TACR3	N
Talin	TLN	G
Talin, TLN		S
T-cell acute lymphocytic leukemia 1	TAL1	I
T-cell acute lymphocytic leukemia 2	TAL2	I
T-cell receptor, alpha	TCRA	I
T-cell receptor, delta	TCRD	I
Telomerase protein component		E
Tenascin (cytotactin)		S
Tenascin XA	TNXA	S
Terminal deoxynucleotidyltransferase, TDT		E
Testis-specific protein Y	TSPY	G
Thrombopoietin	THPO	G
Thromboxane A synthase 1	TBXAS1	I
Thromboxane A2	TXA2	I
Thromboxane A2 receptor	TBXA2R	I
Thy-1 T-cell antigen	THY1	I
Thymidylate synthase	TYMS	E
Thymopoietin	TMPO	G
Thymosin		I
Thyroid-stimulating hormone receptor	TSHR	G
Thyroid-stimulating hormone, alpha	TSHA	G
Thyroid-stimulating hormone, beta	TSHB	G

Thyrotropin releasing hormone	TRH	N
Thyrotropin releasing hormone	TRH	G
Thyrotropin releasing hormone receptor	TRHR	N
Tip-associated protein	TAP	I
Tissue inhibitor of metalloproteinase 1, TIMP1	TIMP1	E
Tissue inhibitor of metalloproteinase 2, TIMP2	TIMP2	E
Tissue inhibitor of metalloproteinase 3, TIMP3	TIMP3	E
Tissue inhibitor of metalloproteinase 4, TIMP4	TIMP4	E
Topoisomerase II		E
Transacylase		E
Transcobalamin 1, TCN1		T
Transcobalamin 2, TCN2	TCN2	T
Transcription factor 1, hepatic	TCF1	G
Transcription factor 2, hepatic	TCF2	G
Transcription factor 3	TCF3	G
Transcription factor binding to IGHM enhancer 3	TFE3	G
Transcription termination factor, RNA polymerase 1	TTF1	G
Transcription termination factor, RNA polymerase 2	TTF2	G
Transcription termination factor, RNA polymerase 3	TTF3	G
Transferrin	TF	G
Transferrin receptor	TFRC	G
Transforming growth factor, alpha	TGFA	G
Transforming growth factor, beta 2	TGFB2	G
Transforming growth factor, beta induced	TGFB1	G
Transforming growth factor, beta receptor 2	TGFBR2	G
Translocation in renal carcinoma on chromosome 8 gene	TRC8	G
Tuberous sclerosis 1	TSC1	G
Tuberous sclerosis 2	TSC2	G
Tubulin		S
Tumor susceptibility gene 101	TSG101	G
Tumour necrosis factor (TNF) receptor associated factor 1	TRAF1	I
Tumour necrosis factor (TNF) receptor associated factor 2	TRAF2	I
Tumour necrosis factor (TNF) receptor associated factor 3	TRAF3	I
Tumour necrosis factor (TNF) receptor associated factor 4	TRAF4	I
Tumour necrosis factor (TNF) receptor associated factor 5	TRAF5	I
Tumour necrosis factor (TNF) receptor associated factor 6	TRAF6	I
Tumour necrosis factor alpha	TNFA	I

Tumour necrosis factor alpha receptor	TNFAR	I
Tumour necrosis factor beta	TNFB	I
Tumour necrosis factor beta receptor	TNFBR	I
Tumour protein p53	TP53, P53	G
Tumour protein p63	TP63	G
Tumour protein p73	TP73	G
Tumour protein, translationally-controlled 1	TPT1	G
Tumour suppressor gene DRA	DRA	I
Twist (Drosophila) homolog	TWIST	G
Ubiquitin		G
Ubiquitin activating enzyme, E1		E
Ubiquitin B	UBB	G
Ubiquitin C	UBC	G
Ubiquitin fusion degeneration 1-like	UFD1L	G
Ubiquitin protein ligase E3A	UBE3A	E
Vacuolar proton pump, subunit 1	VPP1	N
Vacuolar proton pump, subunit 3	VPP3	N
Vasoactive intestinal polypeptide	VIP	N
Vasoactive intestinal polypeptide receptor	VIPR	N
Vitamin B12-binding (R) protein		G
Vitamin D receptor	VDR	G
v-myc avian myelocytomatosis viral oncogene homolog	MYC	G
Von Hippel-Lindau gene	VHL	G
Werner syndrome helicase	WRN	G
Wilms tumour gene 1	WT1	G
Wilms tumour gene 2	WT2	G
Wilms tumour gene 4	WT4	G
Winged helix nude	WHN	G
Wiskott-Aldrich syndrome protein	WASP, THC	I
Xeroderma pigmentosum, complementation group B	XPB	E
Xeroderma pigmentosum, complementation group C		E
Xeroderma pigmentosum, complementation group D		E
Xeroderma pigmentosum, complementation group E		E
Xeroderma pigmentosum, complementation group F	XPF	E
Xeroderma pigmentosum, complementation group G	ERCC5	E
X-ray repair gene	XRCC9	G
YY1 transcription factor	YY1	G
Zinc finger protein 198	ZIC198	S
Zinc finger protein HRX	ALL1	I

In a third aspect.

### CENTRAL NERVOUS SYSTEM (NEUROLOGICAL, NEUROPSYCHIATRIC, PSYCHIATRIC, PSYCHOLOGICAL AND SOCIAL) DYSFUNCTION, DISEASE AND DAMAGE

The invention relates to a method of assessing the risk of developing the clinical or social consequences of central nervous system dysfunction, damage or disease and indicating appropriate therapeutic interventions.

The 1990's has been heralded as the 'decade of the brain' and the cumulative efforts of research groups around the world have led to considerable advances in our understanding of the principles, physiology and mechanisms of brain or more properly central nervous system (CNS) function.

The primary role of CNS function is to gather, integrate, and evaluate information concerning the organisms internal and external environments and then formulate actions designed to achieve the organisms' goals. In man such a simplistic summary lies behind our understanding of the physiology of the simple reflex arc and our crude attempts at investigating the information processing/physiology interface which enables the higher cognitive functions (e.g. reading, writing, mathematics, music etc.).

The CNS often referred to as a single organ in the body. In reality it is a closely interconnected series of specialised sub-organs (e.g. hypothalamus, cortex, cerebellum, thalamus etc) which are known to have discrete functions. Understanding brain function implies a clear understanding of the biochemical, physiological and informational parameters which enable the interconnections between these sub-organs and which control the nature, direction and volume of information flow between them.

The CNS is made up of two major types of cells – neurones and glia. Neurones have a variety of morphological types (Betz cell, pyramidal cell etc) but each type has a common set of morphological features – cell body, dendrites, axon and axon terminals. Axons can be very long (up to 1 metre for spinal tracts) and project to distant regions of the CNS. Bundles of axons form the white matter tracts within the CNS. In terms of the processes of communication dendrites and axons are critical features as incoming information is usually received on dendrites whereas axons are the channels for information outflow. Communication between neurones is achieved by means of the release of neurotransmitters (a label which includes many types of molecules e.g. peptides, amines and nitric oxide) from specialised sites on axons – synapses. Thus, the release of neurotransmitters and their movement across the synaptic gap and interaction with receptor sites on neighbouring neurones is the core functional mechanism in the CNS.

Glial cells outnumber neurones and are divided into astrocytes, oligodendrocytes and microglia. Glia had been considered as having a 'support' role for neuronal functioning. It is now realised that their functions extend far beyond this and that they may be actively involved in the information processing function and in the



modulation of the neuronal environment. Microglia have a critical role in the response of the CNS to disease, infection and damage. Such events 'activate' microglia causing them to release a variety of factors (e.g. cytokines, growth factors) which aid the recovery and regeneration of CNS functions.

The point to point contact between specific sets of neurones is critical for CNS function. Failure of this point to point contact either through dysfunction, damage or disease lies at the heart of the appearance of neurological, psychiatric, psychological or social difficulties following such events (Roberts, Leigh and Weinberger 1993, Youdofsky and Hales 1994, Gelder 1996, Weatherall, Leadingham and Warrell 1996) Lishman 1997).

The information processing capacity of the CNS can be compromised in a number of ways. These can be categorised as: dysfunction, damage or disease.

### CNS DYSFUNCTION

A number of disorders present as subtle or marked changes from socially accepted norms in the way that ideas, thoughts or mood states are experienced or acted upon. In many cases although the presence of such phenomena can be readily documented at clinical interview, the identification of a CNS lesion or biochemical abnormality is not possible. Examples of this type of CNS dysfunction include, depression, anxiety, obsessive behaviour, delusions, hallucinations, trances and fugue-like states (Gelder et al 1996, Lishman 1997). Such types of disorders include;

Schizophrenia

Depression

Anxiety states

Mania

Delirium

Paranoia

Personality disorders

Sleep disorders

Psychopathic disorders

Sociopathic disorders

In many of these disorders drug therapy designed to modify the actions of particular neurotransmitters can be very effective (e.g. neuroleptics, lithium, benzodiazepines).

### CNS DAMAGE

The CNS is a metabolically active soft jelly like tissue, floating within a rigid box – the skull. As a result of its physical structure it is vulnerable to damage caused by events which physically separate nerve connections, alter patterns of nerve growth, cause fluctuations in the delivery of nutrients and oxygen (either directly or as a result of compromised function in other organs) or clearance of toxins or wastes or result in a space occupying lesion. Common causes of CNS damage include;

Head and spinal trauma

Birth complications

Stroke

Cardiovascular disease

Epilepsy  
Tumours  
Blood-brain barrier compromise  
Drug abuse  
Oxygen deprivation  
Fever  
Malnutrition  
Developmental disorders

### CNS DISEASE

A large number of diseases are known which result in compromise or degeneration of CNS tissues (Roberts, Leigh and Weinberger 1993, Ellison et al 1997, Lishman 1997). These diseases range from infection with viruses or bacteria, to degenerative disorders affecting specific regions, to auto-immune disorders. In many cases the incidence of disease will rise steeply with age (particularly true of the dementias). In a number of diseases genetic factors are known to be of particular importance (e.g. presenilin in Alzheimer's disease, prion protein in prion disease). Common diseases affecting the CNS include;

Alzheimer's disease  
Parkinsons disease  
Cerebrovascular disease  
Meningitis  
AIDS dementia complex  
Endocrine disorders  
Muscular dystrophy  
Multiple sclerosis

CNS dysfunction, damage and disease can give rise to a wide variety of symptoms, many of which will have profound clinical and social consequences. Symptoms and signs can range from mild forgetfulness to full blown dementia and slight tremors to status epilepticus. Because of the functional parcellation of the CNS the exact constellation of symptoms in any given case of CNS dysfunction, damage or disease will depend upon the site and extent of the CNS which has had its function compromised (Lishman 1997). The scientific understanding of CNS function has been harnessed to this clinical need and as a result drugs used to modify CNS function are now one of the most widely used category of drugs in medicine. Anaesthetics for pain relief, anti-psychotics for the symptoms of schizophrenia and anti-epileptics for seizure control are some examples of the diverse types of drugs currently available. In many cases good or adequate relief of symptoms can be achieved by appropriate treatments. However, many drugs used to treat CNS dysfunction, damage and disease have significant side effects and need to be used in a carefully controlled way (e.g. anti-psychotics are associated with the appearance of extrapyramidal symptoms, tardive dyskinesias and neuroleptic malignant syndrome Gelder et al 1996, Brody, Larner and Minneman 1998,).

Although some success has been achieved with drugs designed to modulate the activity of neurotransmitters and their receptors (e.g. selective serotonin reuptake inhibitors for depression, cholinomimetics for cognition). Less progress has been

made in therapeutic interventions aimed at restoring or regenerating lost or damaged nerve connections (e.g. such as those following spinal trauma) or aimed at replacing or augmenting neurones damaged or destroyed as a result of degenerative diseases (e.g. neuronal loss in Parkinson's disease or prion disease). Preliminary studies with such approaches as neuronal transplantation or implants or infusion of growth factors have demonstrated limited success.

The physiology and control of the body's central nervous system is extremely complex and involves the synergistic or inhibitory interaction between multiple regulatory pathways and molecular cascades. Variation in the functionality of the proteins involved in these processes will, inevitably, cause or have an impact on the functioning of these systems or an individual's attempts to minimise damage and restore function following dysfunction, damage or disease in these systems. A number of constitutional factors are known to impact on the individual's ability to deal with and recover from CNS dysfunction, damage or disease including genetic history, age, sex, nutritional status, pre-existing disease or injury, drug treatments and socio-economic circumstances. Genetic variation within individuals is also a key factor although the extent and nature of the genes involved and their precise impact on prognosis, complications, efficacy of therapeutic intervention and eventual recovery of function is largely unknown.

The individual variability in response to damage, dysfunction or disease affecting the CNS and the associated variation in symptomatology, response to therapy and adverse events resulting from therapeutic interventions lies at the heart of the difficulties experienced in the healthcare and social management of CNS damage, dysfunction or disease.

We have elaborated on the value and utility to be derived from the gathering together of the genes which form the core gene list for this particular Genostic system.

These genes are elaborated below:

#### KEY TO 'PROTEIN FUNCTION' COLUMN

E ENZYME  
T TRANSPORT & STORAGE  
S STRUCTURAL  
I IMMUNITY  
N NERVOUS TRANSMISSION  
G GROWTH & DIFFERENTIATION

#### CNS GENE LIST

CNS GENE LIST	HUGO gene symbol	Protein function
11beta hydroxysteroid dehydrogenase 2	HSD11B2	E
2,3-bisphosphoglycerate mutase	BPGM	E
2,4-dienoyl CoA reductase	DECR	E
3 beta hydroxysteroid dehydrogenase 2	HSD3B2	E
3-oxoacid CoA transferase	OXCT	E

4-hydroxyphenylpyruvate dioxygenase	HPD	E
5,10-methylenetetrahydrofolate reductase (NADPH)	MTHFR	E
6-pyruvoyltetrahydropterin synthase	PTS	E
Acetoacetyl 2-CoA-thiolase	ACAT2	E
Acetyl CoA acyltransferase	ACAA	E
Acetyl CoA carboxylase alpha	ACACA	E
Acetylcholine receptor, nicotinic, alpha A1	CHRNA1	N
Acetylcholine receptor, nicotinic, alpha A2	CHRNA2	N
Acetylcholine receptor, nicotinic, alpha A3	CHRNA3	N
Acetylcholine receptor, nicotinic, alpha A4	CHRNA4	N
Acetylcholine receptor, nicotinic, alpha A5	CHRNA5	N
Acetylcholine receptor, nicotinic, alpha A6	CHRNA6	N
Acetylcholine receptor, nicotinic, alpha A7	CHRNA7	N
Acetylcholine receptor, nicotinic, beta 1	CHRNA1	N
Acetylcholine receptor, nicotinic, beta 2	CHRNA2	N
Acetylcholine receptor, nicotinic, beta 3	CHRNA3	N
Acetylcholine receptor, nicotinic, beta 4	CHRNA4	N
Acetylcholine receptor, nicotinic, epsilon	CHRNA5	N
Acetylcholine receptor, nicotinic, gamma	CHRNA6	N
Acetylcholinesterase	CHRNA7	N
Acyl CoA dehydrogenase, long chain	CHRNA1	N
Acyl CoA dehydrogenase, medium chain	CHRNA2	N
Acyl CoA dehydrogenase, short chain	CHRNA3	N
Acyl-CoA thioesterase	CHRNA4	N
Adaptin, beta 3A	CHRNA5	N
Adducin, alpha	CHRNA6	N
Adducin, beta	CHRNA7	N
Adenosine monophosphate deaminase	CHRNA1	N
Adenosine receptor A1	CHRNA2	N
Adenosine receptor A2A	CHRNA3	N
Adenosine receptor A2B	CHRNA4	N
Adenosine receptor A3	CHRNA5	N
Adenyl cyclase	CHRNA6	N
Adenylate cyclase 1	CHRNA7	N
Adenylate cyclase 2	CHRNA1	N
Adenylate cyclase 3	CHRNA2	N
Adenylate cyclase 4	CHRNA3	N
Adenylate cyclase 5	CHRNA4	N
Adenylate cyclase 6	CHRNA5	N
Adenylate cyclase 7	CHRNA6	N
Adenylate cyclase 8	CHRNA7	N
Adenylate cyclase 9	CHRNA1	N
Adenylosuccinate lyase	CHRNA2	N
Adrenergic receptor, alpha1	CHRNA3	N
Adrenergic receptor, alpha2	CHRNA4	N
Adrenergic receptor, beta1	CHRNA5	N
Adrenergic receptor, beta2	CHRNA6	N

Adrenergic receptor, beta3	ADRB3	N
Adrenocorticotrophic hormone (ACTH) receptor	ACTHR	G
Adrenoleukodystrophy gene	ALD	E
Albumin, ALB	ALB	T
Aldehyde dehydrogenase 10	ALDH10	E
Aldolase A	ALDOA	E
Aldolase B	ALDOB	E
Aldolase C	ALDOC	E
Aldosterone receptor	MLR	G
Alpha 2 macroglobulin	A2M	I
alpha tectorin	TECTA	G
alpha thalassemia gene	ATRX	N
alpha1-antitrypsin	PI	E
alpha2-antiplasmin	PLI	E
alpha-Galactosidase A	GLA	E
alpha-ketoglutarate dehydrogenase		E
alpha-L-Iduronidase	IDUA	E
alpha-synuclein	SNCA	N
Aminomethyltransferase	AMT	E
Aminopeptidase P	XPNPEP2	E
Amylo-1,6-glucosidase	AGL	E
Amyloid beta (A4) precursor protein-binding, APBB1	APBB1	N
Amyloid beta A4 precursor protein	APP	N
Amyloid beta A4 precursor-like protein	APLP	N
Angiopoietin 1	ANGPT1	G
Angiopoietin 2	ANGPT2	G
Angiotensin converting enzyme	ACE, DCP1	E
Angiotensin receptor 1	AGTR1	T
Angiotensin receptor 2	AGTR2	T
Angiotensinogen	AGT	E
Antidiuretic hormone receptor	ADHR	T
Antithrombin III	AT3	E
Apolipoprotein A I	APOA1	T
Apolipoprotein A II	APOA2	T
Apolipoprotein B	APOB	T
Apolipoprotein C1	APOC1	T
Apolipoprotein C2	APOC2	T
Apolipoprotein C3	APOC3	T
Apolipoprotein D	APOD	T
Apolipoprotein E	APOE	T
Apolipoprotein H	APOH	T
Archaeate-scute homolog 2	ASH2	G
Arginase	ARG1	E
Arginine vasopressin	AVP	N
Arginosuccinate lyase	ASL	E
Arginosuccinate synthetase	ASS	E

Arylsulfatase A	ARSA	E
Arylsulfatase B	ARSB	E
Arylsulfatase D	ARSD	E
Arylsulfatase E	ARSE	E
Arylsulfatase F	ARSF	E
Aspartoacylase	ASPA	E
Aspartylglucosaminidase	AGA	E
Astrotactin	ASTN	G
Ataxia telangiectasia complementation group D	ATD, ATDC	G
Ataxia telangiectasia gene, AT	ATM	G
ATP-binding cassette transporter 7	ABC7	I
Atrial natriuretic peptide	ANP	G
Atrial natriuretic peptide receptor A	NPR1	G
Atrial natriuretic peptide receptor B	NPR2	G
Atrial natriuretic peptide receptor C	NPR3	G
Bagpipe homeobox, drosophila homolog of, 1	BAPX1	G
beta-Glucuronidase	GUSB	E
beta-synuclein	SNCB	N
Bilirubin UDP-glucuronosyltransferase		E
Bloom syndrome protein	BLM	G
Bradykinin receptor B1		I
Bradykinin receptor B2		I
Brain derived neurotrophic factor	BDNF	G
Brain derived neurotrophic factor (BDNF) receptor	BDNFR	G
Butyrylcholinesterase	BCHE	E
Ca(2+) transporting ATPase, slow twitch	ATP2A2	T
Cadherin E	CDH1	G
Cadherin EP		G
Cadherin N	CDH2	G
Cadherin P	CDH3	G
Calbindin 1	CALB1	G
Calbindin D9K	CALB3	G
Calcineurin A1	CALNA1	I
Calcineurin A2	CALNA2	I
Calcineurin A3	CALNA3	I
Calcineurin B		I
Calcitonin/Calcitonin gene-related peptide alpha	CALCA	N
Calcium channel, voltage-dependent, alpha 1F subunit	CACNA1F	N
Calcium channel, voltage-dependent, Alpha-1B (CACNL1A5)	CACNA1B	N
Calcium channel, voltage-dependent, Alpha-1C	CACNA1C	N
Calcium channel, voltage-dependent, Alpha-1D	CACNA1D	N

Calcium channel, voltage-dependent, Alpha-1E (CACNL1A6)	CACNA1E	N
Calcium channel, voltage-dependent, Alpha-2/delta	CACNA2	N
Calcium channel, voltage-dependent, Beta 1	CACNB1	N
Calcium channel, voltage-dependent, Beta 3	CACNB3	N
Calcium channel, voltage-dependent, L type, alpha 1S subunit	CACNA1S	N
Calcium channel, voltage-dependent, Neuronal, Gamma	CACNG2	N
Calcium channel, voltage-dependent, P/Q type, alpha 1A subunit	CACNA1A	N
Calcium channel, voltage-dependent, T-type		N
Calmodulin 1	CALM1	G
Calmodulin 2	CALM2	G
Calmodulin 3	CALM3	G
Calmodulin-dependant protein kinase II	CAMK2A	G
Calnexin	CANX	G
Calpain	CAPN, CAPN3	E
Calretinin	CALB2	N
Cannabinoid receptor	CNR1	N
Carbonic anhydrase 3	CA3	E
Carbonic anhydrase 4	CA4	E
Carbonic anhydrase, alpha	CA1	E
Carbonic anhydrase, beta	CA2	E
Cardiac-specific homeobox, CSX	CSX	G
Carnitine acetyltransferase	CRAT	E
Carnitine acylcarnitine translocase	CACT	E
Carnitine transporter protein	CDSP, SCD	T
Carnosinase		N
Caspase 1	CASP1	G
Catechol-O-methyltransferase	COMT	E
CD1	CD1	I
CD4	CD4	I
Cell adhesion molecule, neural, NCAM1	NCAM1	G
Cell adhesion molecule, neural, NCAM120	NCAM120	G
Cell adhesion molecule, neural, NCAM2	NCAM2	G
Ceroid lipofuscinosis neuronal 2	CLN2	N
Ceroid lipofuscinosis neuronal 3	CLN3	N
Ceroid lipofuscinosis neuronal 4	CLN4	N
Ceroid lipofuscinosis neuronal 5	CLN5	N
Ceroid lipofuscinosis neuronal 6	CLN6	N
Chemokine receptor CCR2	CCR2	I
Chemokine receptor CCR3	CCR3	I
Chemokine receptor CCR5	CCR5	I
Chemokine receptor CXCR4	CXCR4	I
Chloride channel 1, skeletal muscle	CLCN1	S
Cholecystokinin	CCK	N

Cholecystikinin B receptor	CCKBR	N
Choline acetyltransferase	CHAT	E
Choroideremia gene	CHM	S
Chromogranin A	CHGA	G
Chymotrypsinogen		E
Ciliary neurotrophic factor (CNTF)	CNTF	G
Ciliary neurotrophic factor (CNTF) receptor	CNTFR	G
Clathrin		T
CoA transferase		E
Cochlin	COCH	I
Cockayne syndrome gene, CKN1	CKN1	G
Cofilin		S
Collagen I alpha 1	COL1A1	S
Collagen I alpha 2	COL1A2	S
Collagen II alpha 1	COL2A1	S
Collagen III alpha 1	COL3A1	S
Collagen IV alpha 1	COL4A1	S
Collagen IV alpha 2	COL4A2	S
Collagen IV alpha 3	COL4A3	S
Collagen IV alpha 4	COL4A4	S
Collagen IV alpha 5	COL4A5	S
Collagen IV alpha 6	COL4A6	S
Collagen IX alpha 2	COL9A2, EDM2	S
Collagen IX alpha 3	COL9A3	S
Collagen receptor	COLR	S
Collagen V alpha 1	COL5A1	S
Collagen V alpha 2	COL5A2	S
Collagen VI alpha 1	COL6A1	S
Collagen VI alpha 2	COL6A2	S
Collagen VI alpha 3	COL6A3	S
Collagen VII alpha 1	COL7A1	S
Collagen X alpha 1	COL10A1	S
Collagen X alpha 1	COL11A1	S
Collagen XI alpha 2	COL11A2	S
Collagen XVII alpha 1	COL17A1	S
Collagenic-like tail subunit of asymmetric acetylcholinesterase	COLQ	E
Colony-stimulating factor 1	CSF1	G
Colony-stimulating factor 1 receptor	CSF1R	G
Colony-stimulating factor 2	CSF2	G
Colony-stimulating factor 2 alpha receptor	CSF2RA	G
Colony-stimulating factor 2 beta receptor	CSF2RB	G
Complex V	MTATP6	E
Cone-rod homeobox-containing gene	CRX	G
Contactin	CNTN1	G
Corticotrophin-releasing hormone	CRH	T
Corticotrophin-releasing hormone receptor	CRHR1	T
Creb binding protein	CREBBP	G



Cu <sup>2+</sup> transporting ATPase beta polypeptide	ATP7B	E
Cyclic AMP response element binding protein	CREB	G
Cyclic AMP-dependent protein kinase	PKA	E
Cyclic nucleotide gated channel alpha 1, CNGA1	CNGA1	N
Cyclic nucleotide gated channel alpha 3, CNGA3	CNGA3	N
Cyclic nucleotide phosphodiesterase 1B	PDE1B	E
Cyclic nucleotide phosphodiesterase 1B1	PDE1B1	E
Cyclic nucleotide phosphodiesterase 2A3	PDE2A3	E
Cyclic nucleotide phosphodiesterase 3A	PDE3A	E
Cyclic nucleotide phosphodiesterase 3B	PDE3B	E
Cyclic nucleotide phosphodiesterase 4A	PDE4A	E
Cyclic nucleotide phosphodiesterase 4C	PDE4C	E
Cyclic nucleotide phosphodiesterase 5A	PDE5A	E
Cyclic nucleotide phosphodiesterase 6A	PDE6A	E
Cyclic nucleotide phosphodiesterase 6B	PDE6B	E
Cyclic nucleotide phosphodiesterase 7	PDE7	E
Cyclic nucleotide phosphodiesterase 8	PDE8	E
Cyclic nucleotide phosphodiesterase 9A	PDE9A	E
Cyclin-dependent kinase 2	CDK2	G
Cyclooxygenase 1	COX1	E
Cyclooxygenase 2	COX2	E
CYP11A1	CYP11A1	E
CYP11B1	CYP11B1	E
CYP11B2	CYP11B2	E
CYP17	CYP17	E
CYP19	CYP19	E
CYP1A1	CYP1A1	E
CYP1A2	CYP1A2	E
CYP1B1	CYP1B1	E
CYP21	CYP21	E
CYP24	CYP24	E
CYP27	CYP27	E
CYP27B1	PDDR	E
CYP2A1	CYP2A1	E
CYP2A13	CYP2A13	E
CYP2A3	CYP2A3	E
CYP2A6V2	CYP2A6V2	E
CYP2A7	CYP2A7	E
CYP2B6	CYP2B6	E
CYP2C18	CYP2C18	E
CYP2C19	CYP2C19	E
CYP2C8	CYP2C8	E
CYP2C9	CYP2C9	E
CYP2D6	CYP2D6	E
CYP2E1	CYP2E1	E
CYP2F1	CYP2F1	E

CYP2J2	CYP2J2	E
CYP3A3	CYP3A3	E
CYP3A4	CYP3A4	E
CYP3A5	CYP3A5	E
CYP3A7	CYP3A7	E
CYP4A11	CYP4A11	E
CYP4B1	CYP4B1	E
CYP4F2	CYP4F2	E
CYP4F3	CYP4F3	E
CYP51	CYP51	E
CYP5A1	CYP5A1	E
CYP7A	CYP7A	E
CYP8	CYP8	E
Cystathionase	CTH	E
Cystathione beta synthase	CBS	E
Cystatin B	CSTB	T
Cystatin C	CST3	T
Cystinosin	CTNS	T
Cytidine deaminase	CDA	E
Cytidine-5-prime-triphosphate synthetase	CTPS	E
Cytochrome a		E
Cytochrome c		E
Cytochrome c oxidase, MTCO		E
Cytokine-suppressive antiinflammatory drug-binding protein 1	CSBP1	I
Cytokine-suppressive antiinflammatory drug-binding protein 2	CSBP2	I
DAX1 nuclear receptor	DAX1	I
Deafness autosomal dominant 5	DFNA5	N
Deafness dystonia peptide	DDP	N
Deleted in malignant brain tumours 1	DMBT1	G
Delta aminolevulinate dehydratase	ALAD	E
Delta-7-dehydrocholesterol reductase	DHCR7	E
DHEA sulfotransferase	STD	E
Diaphanous 1	DIAPH1	N
Diaphanous 2	DIAPH2	N
Dihydrolipoamide branched chain transacylase	DBT	N
Dihydrolipoamide dehydrogenase	DLD	N
Dihydrolipoyl dehydrogenase 2	PDHA	E
Dihydrolipoyl transacetylase	PDHA	E
Dihydroxyacetonephosphate acyltransferase	DHAPAT	E
DNA glycosylases		E
DNA helicases		E
DNA Ligase 1	LIG1	E
DNA methyltransferase	DNMT	E
DOPA decarboxylase	DDC	E
Dopamine beta hydroxylase	DBH	E

Dopamine receptors D1	DRD1	N
Dopamine receptors D2	DRD2	N
Dopamine receptors D3	DRD3	N
Dopamine receptors D4	DRD4	N
Dopamine receptors D5	DRD5	N
Doublecortin, DCX	DCX	S
Dynamin	DNM1	G
Dystonia 1	DYT1	S
Dystonia 3	DYT3	S
Dystonia 6	DYT6	S
Dystonia 7	DYT7	S
Dystonia 9	CSE	S
Dystrophia myotonica	DM, DMPK	E
Dystrophia myotonica, atypical	DM2	E
Dystrophin	DMD	S
Ectodermal Dysplasia 1 gene	ED1	S
Electron-transferring-flavoprotein alpha	ETFA	T
Electron-transferring-flavoprotein beta	ETFB	T
Electron-transferring flavoprotein dehydrogenase	ETFDH	E
Emerin	EMD	T
Empty spiracles (drosophila) homologue 1	EMX1	G
Empty spiracles (drosophila) homologue 2	EMX2	G
Endobrevin	VAMP8	N
Endothelin 1	EDN1	N
Endothelin 2	EDN2	N
Endothelin 3	EDN3	N
Endothelin converting enzyme	ECE1	N
Endothelin receptor type A	EDNRA	N
Endothelin receptor type B	EDNRB	N
Enolase	ENO1	E
Enoyl CoA isomerase		E
Enoyl CoA reductase		E
Enterokinase	PRSS7, ENTK	E
Ephrin-A	EFNA	G
Ephrin-B	EFNB	G
Epidermal growth factor	EGF	G
Epidermal growth factor receptor	EGFR	G
Epilepsy, progressive myoclonic 2 gene	EPM2A	E
EWS RNA-binding protein	EWSR1	G
Excision repair complementation group 4 protein	ERCC4	E
Exostosin 1	EXT1	S
Exostosin 2	EXT2	S
Factor 1 (No. one)	F1	I
Factor III	F3	I
Factor IX	F9	I
Factor V	F5	I

Factor VII	F7	I
Factor VIII	F8	I
Factor X	F10	I
Factor XI	F11	I
Factor XII	F12	I
Factor XIII A & B	F13A & F13B	I
Fanconi anemia, complementation group A	FANCA	T
Fanconi anemia, complementation group C	FANCC	T
Fanconi anemia, complementation group D	FANCD	T
Fibrillin 2	FBN2	G
Fibrinogen alpha	FGA	S
Fibrinogen beta	FGB	S
Fibrinogen gamma	FGG	S
Fibroblast growth factor	FGF1	G
Fibroblast growth factor receptor 1	FGFR1	G
Fibroblast growth factor receptor 2	FGFR2	G
Fibroblast growth factor receptor 3	FGFR3	G
Fibronectin precursor	FN1	G
Flightless-II, Drosophila homolog of	FLII	G
Follicle stimulating hormone receptor	FSHR, ODG1	G
Follicle stimulating hormone, FSH	FSHB	G
Forkhead transcription factor 10	FKHL10	G
Formiminotransferase		E
Fragile site, folic acid type, rare, fra(X) A	FRAXA	N
Fragile site, folic acid type, rare, fra(X) E	FRAXE	N
Fragile site, folic acid type, rare, fra(X) F	FRAXF	N
Frataxin	FRDA	G
Fructose-1,6-diphosphatase	FBP1	E
Fukuyama type congenital muscular dystrophy	FCMD	G
GABA receptor, alpha 1	GABRA1	N
GABA receptor, alpha 2	GABRA2	N
GABA receptor, alpha 3	GABRA3	N
GABA receptor, alpha 4	GABRA4	N
GABA receptor, alpha 5	GABRA5	N
GABA receptor, alpha 6	GABRA6	N
GABA receptor, beta 1	GABRB1	N
GABA receptor, beta 2	GABRB2	N
GABA receptor, beta 3	GABRB3	N
GABA receptor, gamma 1	GABRG1	N
GABA receptor, gamma 2	GABRG2	N
GABA receptor, gamma 3	GABRG3	N
GABA transaminase	ABAT	E
Galactocerebrosidase	GALC	E
Galactose 1-phosphate uridyl-transferase	GALT	E
Galactosyltransferase 1	GT1	G
Galactosyltransferase, alpha 1,3	GGTA1	G
Galactosyltransferase, beta 3	B3GALT	G

Galanin	GAL	N
Galanin receptor	GALNR1	N
Gamma-glutamyltransferase 1	GGT1	T
Gap junction protein beta 2	GJB2	T
Gap junction protein beta 3	GJB3	T
Gastric Intrinsic factor, GIF	GIF	E
Gastrulation brain homeobox 2	GBX2	G
Geniospasm 1	GSM1	G
Gephyrin		N
Glial-cell derived neurotrophic factor (GDNF) receptor		N
Glial-cell derived neurotrophic factor, GDNF	GDNF	N
Glucosidase, acid alpha	GAA	E
Glutamate decarboxylase, GAD	GAD1	E
Glutamate dehydrogenase	GLUD1	E
Glutamate receptor 1	GLUR1	N
Glutamate receptor 2	GLUR2	N
Glutamate receptor 3	GLUR3	N
Glutamate receptor 4	GLUR4	N
Glutamate receptor 5	GLUR5	N
Glutamate receptor 6	GLUR6	N
Glutamate receptor 7	GLUR7	N
Glutamate receptor, ionotropic, NMDA 1	NMDAR1	N
Glutamate receptor, ionotropic, NMDA 2A	NMDAR2A	N
Glutamate receptor, ionotropic, NMDA 2B	NMDAR2B	N
Glutamate receptor, ionotropic, NMDA 2C	NMDAR2C	N
Glutamate receptor, ionotropic, NMDA 2D	NMDAR2D	N
Glutamate-cysteine ligase	GLCLC	E
Glutaryl-CoA dehydrogenase	GCDH	E
Glutathione	GSH	T
Glutathione S-transferase, GSTZ1	GSTZ1	E
Glutathione synthetase	GSS	E
Glyceraldehyde-3-phosphate dehydrogenase, GAPDH	GAPDH	E
Glycerol kinase	GK	E
Glycinamide ribonucleotide (GAR) transformylase	GART	E
Glycine dehydrogenase	GLDC	E
Glycine receptor, alpha	GLRA2	N
Glycine receptor, beta		N
Glycine transporter	GLYT	N
Glycogen phosphorylase	PYGL	E
GM2 ganglioside activator protein, GM2A	GM2A	E
Gonadotropin releasing hormone receptor	GNRHR	G
GTP cylcohydrolase 1	GCH1	G
Guanidinoacetate N-methyltransferase	GAMT	E
Guanine nucleotide-binding protein, alpha activating activity polypeptide, GNAO	GNAO1	N

Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 1, GNAI1	GNAI1	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 2, GNAI2	GNAI2	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 3, GNAI3	GNAI3	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS1	GNAS1	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS2	GNAS2	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS3	GNAS3	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS4	GNAS4	N
Guanine nucleotide-binding protein, alpha transducing activity polypeptide, GNAT1	GNAT1	N
Guanine nucleotide-binding protein, alpha transducing activity polypeptide, GNAT2	GNAT2	N
Guanine nucleotide-binding protein, beta polypeptide 3	GNB3	N
Guanine nucleotide-binding protein, gamma polypeptide 5	GNG5	N
Guanine nucleotide-binding protein, q polypeptide	GNAQ	N
Guanylate cyclase 2D, membrane (retina-specific)	GUCY2D	E
Guanylate cyclase activator 1A (retina)	GUCA1A	E
Guanylate kinase		E
Guanylyl cyclase		E
Gustducin, alpha (taste-specific G protein)	GDCA	N
Haeme regulated inhibitor kinase		E
Haemoglobin alpha 1	HBA1	T
Haemoglobin alpha 2	HBA2	T
Haemoglobin beta	HBB	T
Haemoglobin delta	HBD	T
Haemoglobin gamma A	HBG1	T
Haemoglobin gamma B	HBG2	T
Haemoglobin gamma G	HBGG	T
Heat shock protein, HSP60		I
Heat shock protein, HSP70		I
Heat shock protein, HSP90		I
Heat shock protein, HSPA1		I
Heat shock protein, HSPA2		I
Heparan sulfamidase		E
Heparin binding epidermal growth factor	HBEGF	G
Heparin Cofactor II	HCF2	I
Hepatic lipase	LIPC	E
Hexosaminidase A	HEXA,TSD	E

Hexosaminidase B	HEXB	E
Hippocampal cholinergic neurostimulating peptide, HCNP		N
Histamine receptors, H1		N
Histamine receptors, H2		N
Histamine receptors, H3		N
Histidase		E
HLA-B associated transcript 1	BAT1	I
HLH transcription factor HAND1	HAND1	G
HLH transcription factor HAND2	HAND2	G
HMG-CoA lyase	HMGCL	E
HMG-CoA reductase	HMGCR	E
Holocarboxylase synthetase	HLCS	E
Homeobox HB9	HLXB9	G
Human atonal gene	ATOH1	G
Hypoxanthine-guanine phosphoribosyltransferase, HGPRT	HPRT	E
Hypoxia inducible factor 1	HIF1A	E
Hypoxia inducible factor 2		E
IC7 A and B		I
Inositol 1,4,5-triphosphate receptor 1	ITPR1	G
Inositol monophosphatase	IMPA1	N
Inositol polyphosphate 1-phosphatase	INPP1	N
Insulin	INS	G
Insulin receptor	INSR	G
Insulin-like growth factor 1	IGF1	G
Insulin-like growth factor 1 receptor	IGF1R	G
Insulin-like growth factor 2	IGF2	G
Insulin-like growth factor 2 receptor	IGF2R	G
Integrin beta 1	ITGB1	G
Integrin beta 2	ITGB2	G
Integrin beta 3	ITGB3	G
Integrin, alpha 1	ITGA1	G
Integrin, alpha M	ITGAM	G
Inter-alpha-trypsin inhibitor, IAT1		E
Interleukin(IL) 1 receptor	IL1R	I
Interleukin(IL) 1, alpha	IL1A	I
Interleukin(IL) 1, beta	IL1B	I
Interleukin(IL) 10	IL10	I
Interleukin(IL) 10 receptor	IL10R	I
Interleukin(IL) 11	IL11	I
Interleukin(IL) 11 receptor	IL11R	I
Interleukin(IL) 12	IL12	I
Interleukin(IL) 12 receptor, beta 1	IL12RB1	I
Interleukin(IL) 13	IL13	I
Interleukin(IL) 13 receptor	IL13R	I
Interleukin(IL) 2	IL2	I
Interleukin(IL) 2 receptor, alpha	IL2RA	I
Interleukin(IL) 2 receptor, gamma	IL2RG	I

Interleukin(IL) 3	IL3	I
Interleukin(IL) 3 receptor	IL3R	I
Interleukin(IL) 4	IL4	I
Interleukin(IL) 4 receptor	IL4R	I
Interleukin(IL) 5	IL5	I
Interleukin(IL) 5 receptor	IL5R	I
Interleukin(IL) 6	IL6	I
Interleukin(IL) 6 receptor	IL6R	I
Interleukin(IL) 7	IL7	I
Interleukin(IL) 7 receptor	IL7R	I
Interleukin(IL) 8	IL8	I
Interleukin(IL) 8 receptor	IL8R	I
Interleukin(IL) 9	IL9	I
Interleukin(IL) 9 receptor	IL9R	I
Interleukin(IL) receptor antagonist 1	IL1RN, IL1RA	I
IP3 kinase		E
Isovaleric acid CoA dehydrogenase	IVD	E
Kallikrein 3	KAK3	I
Kallman syndrome gene 1	KAL1	G
Ketohexokinase	KHK	E
Kininogen, High molecular weight	KNG	I
Kynureninease		E
L1 cell adhesion molecule	L1CAM	N
Laminin 5, alpha 3	LAMA3	G
Laminin 5, beta 3	LAMB3	G
Laminin 5, gamma 2	LAMC2	G
Laminin M	LAMM	G
Laminin receptor 1	LAMR1	G
Latent transforming growth factor-beta binding protein 2	LTBP2	G
Leptin	LEP	G
Leptin receptor	LEPR	G
Leukaemia inhibitory factor	LIF	G
Leukaemia inhibitory factor receptor	LIFR	G
Leukin		I
Leukocyte-specific transcript 1	LST-1	I
Leukotriene A4 hydrolase		I
Leukotriene A4 synthase	LTA4S	E
Leukotriene B4 receptor		I
Leukotriene B4 synthase	LTB4S	E
Leukotriene C4 receptor		I
Leukotriene C4 synthase	LTC4S	E
Leukotriene D4/E4 receptor		I
LIM homeobox protein 1	LHX1	G
LIM homeobox protein 2	LHX2	G
LIM homeobox protein 3	LHX3	G
LIM homeobox protein 4	LHX4	G
Limbic associated membrane protein	LAMP	G



LIM-domain only protein 1	LMO1	G
LIM-domain only protein 2	LMO2	G
LIM-domain only protein 3	LMO3	G
LIM-domain only protein 4	LMO4	G
LIM-Kinase I (LINK-I)		I
Lipoprotein receptor, Low Density	LDLR	T
Lipoprotein, High Density	HDLDT1	T
Lipoprotein, Intermediate Density		T
Lipoprotein, Low Density 1		T
Lipoprotein, Low Density 2		T
Lipoprotein, Very Low Density	VLDLR	T
Low density lipoprotein receptor-related protein precursor	LRP	T
Lymphoid enhancer-binding factor	LEF-1	G
MAD (mothers against decapentaplegic, Drosophila) homologue 4	MADH4	G
Malonyl CoA decarboxylase		E
Mannosidase, alpha B lysosomal	MANB	E
Mannosidase, beta A lysosomal	MANBA	E
Marenostrin	MEFV	T
Melatonin receptor 1A	MTNR1A	N
Melatonin receptor 1B	MTNR1B	N
Methylguanine-DNA methyltransferase	MGMT	E
Methylmalonyl-CoA mutase	MUT	E
Mevalonate kinase	MVK	E
Microsomal triglyceride transfer protein	MTP	T
Microtubule associated protein	MAP	S
Mismatch repair gene, PMSL2	PMS2	G
Molybdenum cofactor synthesis 1	MOCS1	E
Molybdenum cofactor synthesis 2	MOCS2	E
Monoamine oxidase A	MAOA	E
Monoamine oxidase B	MAOB	E
Msh homeobox homolog 2	MSX2	G
Mucopolidoses	GNPTA	E
Muscarinic receptor, M1	CHRM1	N
Muscarinic receptor, M2	CHRM2	N
Muscarinic receptor, M3	CHRM3	N
Muscarinic receptor, M4	CHRM4	N
Muscarinic receptor, M5	CHRM5	N
Myelin protein peripheral 22	PMP22	S
Myelin protein zero	MPZ	S
Myogenic factor 3	MYF3	G
Myogenic factor 4	MYF4	G
Myogenic factor 5	MYF5	G
Myosin 15	MYO15	S
Myosin 6	MYO6	S
Myosin 7A	MYO7A	S
Myotubularin	MTM1	S

Na <sup>+</sup> , K <sup>+</sup> ATPase, alpha	ATP1A1	G
Na <sup>+</sup> , K <sup>+</sup> ATPase, beta 1	ATP1B1	G
Na <sup>+</sup> , K <sup>+</sup> ATPase, beta 2	ATP1B2	G
Na <sup>+</sup> , K <sup>+</sup> ATPase, beta 3	ATP1B3	G
N-acetylglucosamine-6-sulfatase	GNS	E
N-acetylglucosaminidase, alpha	NAGLU	E
NADH dehydrogenase		E
NADPH-dependent cytochrome P450 reductase	POR	E
NB6		I
Nebulin	NEB	S
Necdin	NDN	G
Nerve growth factor	NGF	G
Nerve growth factor receptor	NGFR	G
Neural retina-specific gene	NRL	G
Neuraminidase sialidase	NEU	T
Neuregulin	HGL	G
Neurite growth-promoting factor 2	MDK	N
Neurite inhibitory protein		N
Neuroendocrine convertase 1	NEC1, PCSK1	E
Neurofibromin 1	NF1	G
Neurofibromin 2	NF2	G
Neurofilament protein, heavy	NFH	S
Neurofilament protein, NF125	NF150	S
Neurofilament protein, NF200	NF200	S
Neurofilament protein, NF68	NF68	S
Neurokinin A	NKNA	N
Neurokinin B	NKNB	N
Neuronal apoptosis inhibitory protein	NAIP	I
Neuronal molecule-1		I
Neuronal molecule-1 receptor		I
Neuropeptide Y	NPY	N
Neuropeptide Y receptor Y1	NPY1R	N
Neuropeptide Y receptor Y2	NPY2R	N
Neurotensin	NTS	N
Neurotensin receptor	NTSR1	N
Neutral endopeptidase		E
Niemann-Pick disease protein	NPC1	T
Nitric oxide synthase 1, NOS1	NOS1	E
Nitric oxide synthase 2, NOS2	NOS2	E
Nitric oxide synthase 3, NOS3	NOS3	E
Notch 1	NOTCH1	G
Notch 2	NOTCH2	G
Notch 3	NOTCH3	G
Notch ligand - jagged 1	JAG1, AGS	G
Nuclear factor I-kappa-B-like gene	IKBL	I
Nucleoside diphosphate kinase-A	NDPKA	E
Oncogene bcl2		G

Oncogene GLI1	GLI	G
Oncogene GLI2	GLI2	G
Oncogene GLI3	GLI3	G
Oncogene sis	PDGFB	G
Opioid receptor, delta	OPRD1	N
Opioid receptor, kappa	OPRK1	N
Opioid receptor, mu	OPRM1	N
Ornithine delta-aminotransferase	OAT	E
Ornithine transcarbamoylase	OTC, NME1	E
Orthodenticle (Drosophila) homolog 1	OTX1	G
Orthodenticle (Drosophila) homolog 2	OTX2	G
Otoferlin	OTOF	N
Paired box homeotic gene 2	PAX2	G
Paired box homeotic gene 3	PAX3	G
Palmitoyl-protein thioesterase	PPT	T
Parkin	PARK2	N
Patched (Drosophila) homolog, PTCH	PTCH	G
Peanut-like 1	PNUTL1	I
Peptidylglycine alpha-amidating monooxygenase	PAM	E
Peripherin, PRPH		S
Peroxisomal membrane protein 1	PXMP1	S
Peroxisomal membrane protein 3	PXMP3	T
Peroxisome biogenesis factor 1	PEX1	T
Peroxisome biogenesis factor 19	PEX19	T
Peroxisome biogenesis factor 6	PEX6	T
Peroxisome biogenesis factor 7	PEX7	T
Peroxisome receptor 1	PXR1	T
Persyn		S
Phosphate regulating gene with homologies to endopeptidases on the X chromosome	PHEX	G
Phosphatidylinositol transfer protein	PITPN	G
Phosphoglucose isomerase	GPI	E
Phosphoglycerate kinase 1	PGK1	E
Phospholipase A2, group 10	PLA2G10	I
Phospholipase A2, group 1B	PLA2G1B	I
Phospholipase A2, group 2A	PLA2G2A	I
Phospholipase A2, group 2B	PLA2G2B	I
Phospholipase A2, group 4A	PLA2G4A	I
Phospholipase A2, group 4C	PLA2G4C	I
Phospholipase A2, group 5	PLA2G5	I
Phospholipase A2, group 6	PLA2G6	I
Phospholipase C alpha		I
Phospholipase C beta		I
Phospholipase C delta	PLCD1	I
Phospholipase C epsilon		I
Phospholipase C gamma	PLCG1	I
Phosphomannomutase 2	PMM2	G

Phosphoribosyl pyrophosphate synthetase	PRPS1	E
Phytanoyl-CoA hydroxylase	PHYH	G
Plakophilin 1	PKP1	T
Plasminogen	PLG	E
Plasminogen activator inhibitor 1	PAI1	E
Plasminogen activator inhibitor 2	PAI2	E
Plasminogen activator receptor, Urokinase	UPAR; PLAUR	S
Plasminogen activator, Tissue	PLAT; TPA	E
Plasminogen activator, Urokinase	UPA; PLAU	E
Platelet derived growth factor	PDGF	G
Platelet derived growth factor receptor	PDGFR	G
Platelet-activating factor receptor	PAFR	I
Plectin 1	PLEC1	T
Postsynaptic density-95 protein	PSD95	N
Potassium channel, calcium-activated,	KCNN4	N
Potassium channel, subfamily K, member 1	KCNK1	N
Potassium channel, subfamily K, member 2	KCNK2	N
Potassium channel, subfamily K, member 3	KCNK3	N
Potassium inwardly-rectifying channel J1	KCNJ1	N
Potassium voltage-gated channel A1	KCNA1	N
Potassium voltage-gated channel E1	KCNE1	N
Potassium voltage-gated channel Q1	KCNQ1	N
Potassium voltage-gated channel Q2	KCNQ2	N
Potassium voltage-gated channel Q3	KCNQ3	N
Potassium voltage-gated channel Q4	KCNQ4	N
POU domain, class 1, transcription factor 1 (Pit1)	POU1F1	G
POU domain, class 3, transcription factor 4	POU3F4	G
POU domain, class 4, transcription factor 3	POU4F3	G
Prekallikrein		I
Preproenkephalin	PENK	N
Presenilin 1	PSEN1	T
Presenilin 2	PSEN2	T
Prion protein	PRNP	N
Procollagen N-protease		E
Proline dehydrogenase	PRODH	E
Pro-melanin-concentrating hormone	PMCH	G
Proopiomelanocortin	POMC	N
Prosaposin	PSAP	N
Prostacyclin synthase		I
Prostaglandin 15-OH dehydrogenase	HGPD; PGDH	I
Prostaglandin D - DP receptor		I
Prostaglandin E1 receptor		I
Prostaglandin E2 receptor		I
Prostaglandin E3 receptor		I
Prostaglandin F - FP receptor		I
Prostaglandin I2 receptor		T
Prostaglandin IP receptor		I

Protease nexin 2	PN2	E
Protective protein for beta-galactosidase	PPGB	E
Protein C	PROC	I
Protein C inhibitor	PCI	I
Protein kinase C, alpha	PRKCA	E
Protein kinase C, gamma	PRKCG	E
Protein kinase G		E
Protein phosphatase 1, regulatory (inhibitor) subunit 3	PPP1R3	E
Protein S	PROS1	I
Prothrombin precursor	F2	I
Purine nucleoside phosphorylase	NP	E
Pyrroline-5-carboxylate synthetase	PYCS	E
Pyruvate carboxylase	PC	E
Pyruvate decarboxylase	PDHA	E
Ras-G-protein	RAS	G
Rathke pouch homeobox, RPX	RPX	G
Renin	REN	E
Replication factor C	RFC2	E
Retinal pigment epithelium specific protein (65kD)	RPE65	S
Retinaldehyde binding protein 1	RLBP1	T
Retinoblastoma 1	RB1	G
Rhodopsin kinase	RHOK	E
RIGUI	RIGUI	G
S100 calcium-binding protein A1	S100A1	N
S100 calcium-binding protein A2	S100A2	N
S100 calcium-binding protein A3	S100A3	N
S100 calcium-binding protein A4	S100A4	N
S100 calcium-binding protein A5	S100A5	N
S100 calcium-binding protein A6	S100A6	N
S100 calcium-binding protein A7	S100A7	N
S100 calcium-binding protein A8	S100A8	N
S100 calcium-binding protein A9	S100A9	N
S100 calcium-binding protein B	S100B	N
S100 calcium-binding protein P	S100P	N
Secretase, alpha		N
Secretase, beta		N
Secretase, gamma		N
Selectin E	SELE	N
Selectin L	SELL	N
Selectin P	SELP	N
Semaphorin A4	SEMA4	S
Semaphorin A5	SEMA5	S
Semaphorin D		S
Semaphorin E	SEMAE	S
Semaphorin F	SEMA3/F	S
Semaphorin W	SEMAW	S

Serotonin N-acetyltransferase	SNAT	E
Serotonin receptor, 5HT1A	HTR1A	N
Serotonin receptor, 5HT1B	HTR1B	N
Serotonin receptor, 5HT1C	HTR1C	N
Serotonin receptor, 5HT1D	HTR1D	N
Serotonin receptor, 5HT1E	HTR1E	N
Serotonin receptor, 5HT1F	HTR1F	N
Serotonin receptor, 5HT2A	HTR2A	N
Serotonin receptor, 5HT2B	HTR2B	N
Serotonin receptor, 5HT2C	HTR2C	N
Serotonin receptor, 5HT3	HTR3	N
Serotonin receptor, 5HT4	HTR4	N
Serotonin receptor, 5HT5	HTR5	N
Serotonin receptor, 5HT6	HTR6	N
Serotonin receptor, 5HT7	HTR7	N
Signaling lymphocyte activation molecule	SLAM	I
Slug protein		G
Small nuclear ribonucleoprotein polypeptide N	SNRPN	S
Sodium channel, non-voltage gated 1, alpha	SCNN1A	N
Sodium channel, non-voltage gated 1, beta	SCNN1B	N
Sodium channel, non-voltage gated 1, gamma	SCNN1G	N
Sodium channel, voltage gated, type IV, alpha polypeptide	SCN4A	N
Sodium channel, voltage-gated, type 1, beta polypeptide	SCN1B	N
Solute carrier family 1 (amino acid transporter), member 6	SLC1A6	T
Solute carrier family 1 (glial high affinity glutamate transporter), member 3	SLC1A3	T
Solute carrier family 1 (glutamate transporter), member 1	SLC1A1	T
Solute carrier family 1 (glutamate transporter), member 2	SLC1A2	T
Solute carrier family 12, member 1	SLC12A1	T
Solute carrier family 12, member 2	SLC12A2	T
Solute carrier family 12, member 3	SLC12A3	T
Solute carrier family 16 (monocarboxylate transporter), member 1	SLC16A1	T
Solute carrier family 16 (monocarboxylate transporter), member 7	SLC16A7	T
Solute carrier family 18, member 3	SLC18A3	T
Solute carrier family 2 (facilitated glucose transporter), member 1	SLC2A1	T
Solute carrier family 20, member 3	SLC20A3	T
Solute carrier family 25, member 12	SLC25A12	T
Solute carrier family 4 (anion exchanger),	SLC4A1	T

member 1		
Solute carrier family 4 (anion exchanger), member 2	SLC4A2	T
Solute carrier family 4 (anion exchanger), member 3	SLC4A3	T
Solute carrier family 5 (sodium/glucose transporter), member 1	SLC5A1	T
Solute carrier family 5 (sodium/glucose transporter), member 2	SLC5A2	T
Solute carrier family 5 (sodium/glucose transporter), member 5	SLC5A5	T
Solute carrier family 5, member 3	SLC5A3	T
Solute carrier family 6 (GAMMA-AMINOBUTYRIC ACID transporter), member 1	SLC6A1	T
Solute carrier family 6 (neurotransmitter transporter, dopamine), member 3	SLC6A3	T
Solute carrier family 6 (neurotransmitter transporter, noradrenaline), member 2	SLC6A2	T
Solute carrier family 6 (neurotransmitter transporter, serotonin), member 4	SLC6A4	T
Solute carrier family 6, member 6	SLC6A6	T
Solute carrier family 7 (amino acid transporter), member 1	SLC7A1	T
Solute carrier family 7 (amino acid transporter), member 2	SLC7A2	T
Solute carrier family 7 (amino acid transporter), member 7	SLC7A7	T
Somatostatin	SST	N
Somatostatin receptor, SSTR1	SSTR1	N
Somatostatin receptor, SSTR2	SSTR2	G
Somatostatin receptor, SSTR3	SSTR3	N
Somatostatin receptor, SSTR4	SSTR4	N
Somatostatin receptor, SSTR5	SSTR5	N
Spastic paraplegia 7	SPG7	G
Spectrin beta	SPTB	S
Sphingomyelinase	SMPD1	E
Spinocerebellar ataxia 8 gene	SCA8	N
SRY-box 11	SOX11	G
Steroid 5 alpha reductase 1	SRD5A1	E
Steroid 5 alpha reductase 2	SRD5A2	E
Steroid sulphatase	STS	E
Substance P		N
Succinic semi-aldehyde dehydrogenase	ssadh	E
Sulfamidase	SGSH	G
Sulfite oxidase	SUOX	E
Superoxide dismutase 1	SOD1	E
Superoxide dismutase 3	SOD3	E

Surfeit 1	SURF1	G
Survival of motor neuron 1, telomeric	SMN1	T
Synapsin 1a & 1b	SYN1	N
Synapsin 2a & 2b	SYN2	N
Synaptic vesicle amine transporter	SVAT	N
Synaptic vesicle protein 2	SV2	N
Synaptobrevin 1	SYB1	N
Synaptobrevin 2	SYB2	N
Synaptogyrin		N
Synaptophysin	SYP	N
Synaptosomal-associated protein, 25KD	SNAP25	N
Synaptotagmin 1	SYT1	N
Synaptotagmin 2	SYT2	N
Syntaxin 1	STX1	N
Tachykinin receptor, NK1R	TACR1	N
Tachykinin receptor, NK2R	TACR2	N
Tachykinin receptor, NK3R	TACR3	N
Talin	TLN	G
Tau protein	MAPT	S
TEK, tyrosine kinase, endothelial	TEK	E
Telomerase protein component		E
Thiolase, peroxisomal		E
Thrombin receptor	F2R	I
Thrombopoietin	THPO	G
Thromboxane A synthase 1	TBXAS1	I
Thromboxane A2	TXA2	I
Thromboxane A2 receptor	TBXA2R	I
Thy-1 T-cell antigen	THY1	I
Thyroxin-binding globulin	TBG	T
Tocopherol (alpha) transfer protein	TTPA	T
Topoisomerase I		E
Torticollis, keloids, cryptorchidism and renal dysplasia gene	TKCR	G
Transacylase		E
Transferrin receptor	TFRC	G
Transforming growth factor, beta 2	TGFB2	G
Transforming growth factor, beta induced	TGFBI	G
Transforming growth factor, beta receptor 2	TGFBR2	G
Transketolase-like 1	TKTL1	E
Transthyretin	TTR	T
Tremor, essential 1	ETM1	N
Tremor, essential 2	ETM2	N
Triosephosphate isomerase	TPI1	E
Tropomyosin 3 (non-muscle)	TPM3	S
Tryptophan hydroxylase	TPH	E
Tubby-like protein 1	TULP1	G
Tuberous sclerosis 1	TSC1	G
Tuberous sclerosis 2	TSC2	G



Tumour necrosis factor (TNF) receptor associated factor 1	TRAF1	I
Tumour necrosis factor (TNF) receptor associated factor 2	TRAF2	I
Tumour necrosis factor (TNF) receptor associated factor 3	TRAF3	I
Tumour necrosis factor (TNF) receptor associated factor 4	TRAF4	I
Tumour necrosis factor (TNF) receptor associated factor 5	TRAF5	I
Tumour necrosis factor (TNF) receptor associated factor 6	TRAF6	I
Tumour necrosis factor alpha	TNFA	I
Tumour necrosis factor alpha receptor	TNFAR	I
Tumour necrosis factor beta	TNFB	I
Tumour necrosis factor beta receptor	TNFBR	I
Tumour protein p53	TP53, P53	G
Tumour protein p73	TP73	G
Tyrosine aminotransferase	TAT	E
Tyrosine hydroxylase	TH	E
Ubiquitin		G
Ubiquitin B	UBB	G
Ubiquitin C	UBC	G
Ubiquitin carboxyl-terminal esterase L1	UCHL1	G
UDP-glucuronosyltransferase 1	ugt1d, UGT1	E
UDP-glucuronosyltransferase 2	UGT2	E
Urate oxidase	UOX	E
Uridinediphosphate(UDP)-galactose-4-epimerase	GALE	E
Uroporphyrinogen III synthase	UROS	E
Usher syndrome 2A	USH2A	S
Vacuolar proton pump, subunit 1	VPP1	N
Vacuolar proton pump, subunit 3	VPP3	N
Vasoactive intestinal polypeptide	VIP	N
Vasoactive intestinal polypeptide receptor	VIPR	N
Vesicular monoamine transporter 1	VMAT1	N
Vesicular monoamine transporter 2	VMAT2	N
Vitamin B12-binding (R) protein		G
Von Hippel-Lindau gene	VHL	G
Wolf-Hirschhorn syndrome candidate 1 gene	WHSC1	G
Wolfram syndrome 1 gene	WFS1	S
Xanthine dehydrogenase	XDH	E
Xeroderma pigmentosum, complementation group A	XPA	E
Zinc finger protein 2	ZIC2	S

In a fourth aspect.

## BEHAVIOURAL DISTURBANCE

The present invention relates to a method of assessing the risk of developing the symptoms of aggression and behavioural disturbance in patients with psychiatric or neuropsychiatric disorders or following traumatic brain injury, ischaemic brain damage or stroke.

Aggression, irritability and behavioural disturbance are major sources of disability in patients with psychiatric disorders or injury induced brain damage. Such symptoms lead to difficulties in the clinical care of patients, difficulties in the treatment and recovery of patients and lead to stress and anxiety in their carers and families.

Many studies have documented the appearance of aggression and irritability in a subset of patients following traumatic brain injury and also in patients with schizophrenia, depression, epilepsy and dementia (Youdofsky and Hales 1994, Lishman 1997) The biology underpinning the appearance of aggressive symptoms and behavioural disturbance in humans is uncertain and its genetic background unknown (OMIM Database 1998).

Explosive and violent behaviours are a known consequence of focal brain injury and diffuse damage to the central nervous system (Lishman 1997) and are referred to in DSM III-R as the organic personality syndrome. However, it is known that failure to control aggression and disturbed behaviours can occur in the absence of the personality disturbances specified in DSM-III-R.

Aggressive behaviours and associated behavioural disturbance are a relatively common feature of many neuropsychiatric disorders and can often arise in patients following traumatic brain injury, stroke or ischaemic damage following medical procedures.

It is presumed that a similar (although perhaps less extreme) physiology underlies the expression of aggression and behavioural disturbance in persons without the background of a diagnosable disease or psychiatric condition.

Although little is known concerning the pathophysiology of aggression and behavioural disturbance it has been observed that there is considerable inter-personal variation in the likelihood, threshold and magnitude of aggression or behavioural disturbance even in persons suffering from the same clinical condition or experiencing the same social or economic conditions.

It will be appreciated by those skilled in the art that a diagnosis of aggressive behaviours or behavioural disturbances can be made according to recognised criteria (e.g. BEHAVAD).

We have elaborated on the value and utility to be derived from the gathering together of the genes which form the core gene list for this particular Genostic system.

These genes are elaborated below:

# **KEY TO 'PROTEIN FUNCTION' COLUMN**

E ENZYME  
T TRANSPORT & STORAGE  
S STRUCTURAL  
I IMMUNITY  
N NERVOUS TRANSMISSION  
G GROWTH & DIFFERENTIATION

<b>BEHAVIOURAL DISTURBANCE GENE LIST</b>	<b>HUGO gene symbol</b>	<b>Protein function</b>
11beta hydroxysteroid dehydrogenase 2	HSD11B2	E
4-hydroxyphenylpyruvate dioxygenase	HPD	E
Acetylcholine receptor, nicotinic, alpha A1	CHRNA1	N
Acetylcholine receptor, nicotinic, alpha A2	CHRNA2	N
Acetylcholine receptor, nicotinic, alpha A3	CHRNA3	N
Acetylcholine receptor, nicotinic, alpha A4	CHRNA4	N
Acetylcholine receptor, nicotinic, alpha A5	CHRNA5	N
Acetylcholine receptor, nicotinic, alpha A6	CHRNA6	N
Acetylcholine receptor, nicotinic, alpha A7	CHRNA7	N
Acetylcholine receptor, nicotinic, beta 1	CHRNA1	N
Acetylcholine receptor, nicotinic, beta 2	CHRNA2	N
Acetylcholine receptor, nicotinic, beta 3	CHRNA3	N
Acetylcholine receptor, nicotinic, beta 4	CHRNA4	N
Acetylcholine receptor, nicotinic, epsilon	CHRNA5	N
Acetylcholine receptor, nicotinic, gamma	CHRNA6	N
Acetylcholinesterase	ACHE	E
Adenylate cyclase 1	ADCY1	E
Adenylate cyclase 2	ADCY2	E
Adenylate cyclase 3	ADCY3	E
Adenylate cyclase 4	ADCY4	E
Adenylate cyclase 5	ADCY5	E
Adenylate cyclase 6	ADCY6	E
Adenylate cyclase 7	ADCY7	E
Adenylate cyclase 8	ADCY8	E
Adenylate cyclase 9	ADCY9	E
alpha-synuclein	SNCA	N
Amyloid beta A4 precursor protein	APP	N
Amyloid beta A4 precursor-like protein	APLP	N
Androgen binding protein	ABP	T
Androgen receptor	AR	G
Apolipoprotein E	APOE	T
Arginosuccinate synthetase	ASS	E
Ataxia telangiectasia gene, AT	ATM	G
beta-synuclein	SNCB	N

Ca(2+) transporting ATPase, slow twitch	ATP2A2	T
Cannabinoid receptor	CNR1	N
Carbonic anhydrase 3	CA3	E
Carbonic anhydrase 4	CA4	E
Carbonic anhydrase, alpha	CA1	E
Carbonic anhydrase, beta	CA2	E
Catechol-O-methyltransferase	COMT	E
Cholecystokinin	CCK	N
Cholecystokinin B receptor	CCKBR	N
Choline acetyltransferase	CHAT	E
Ciliary neurotrophic factor (CNTF)	CNTF	G
Ciliary neurotrophic factor (CNTF) receptor	CNTFR	G
Corticotrophin-releasing hormone	CRH	T
Corticotrophin-releasing hormone receptor	CRHR1	T
Cryptochrome 1	CRY1	S
Cryptochrome 2	CRY2	S
Cu2+ transporting ATPase beta polypeptide	ATP7B	E
Cyclic AMP-dependent protein kinase	PKA	E
Cyclooxygenase 1	COX1	E
Cyclooxygenase 2	COX2	E
CYP11A1	CYP11A1	E
CYP11B1	CYP11B1	E
CYP11B2	CYP11B2	E
CYP17	CYP17	E
CYP19	CYP19	E
CYP1A1	CYP1A1	E
CYP1A2	CYP1A2	E
CYP1B1	CYP1B1	E
CYP21	CYP21	E
CYP24	CYP24	E
CYP27	CYP27	E
CYP27B1	PDDR	E
CYP2A1	CYP2A1	E
CYP2A13	CYP2A13	E
CYP2A3	CYP2A3	E
CYP2A6V2	CYP2A6V2	E
CYP2A7	CYP2A7	E
CYP2B6	CYP2B6	E
CYP2C18	CYP2C18	E
CYP2C19	CYP2C19	E
CYP2C8	CYP2C8	E
CYP2C9	CYP2C9	E
CYP2D6	CYP2D6	E
CYP2E1	CYP2E1	E
CYP2F1	CYP2F1	E
CYP2J2	CYP2J2	E
CYP3A3	CYP3A3	E
CYP3A4	CYP3A4	E

CYP3A5	CYP3A5	E
CYP3A7	CYP3A7	E
CYP4A11	CYP4A11	E
CYP4B1	CYP4B1	E
CYP4F2	CYP4F2	E
CYP4F3	CYP4F3	E
CYP51	CYP51	E
CYP5A1	CYP5A1	E
CYP7A	CYP7A	E
CYP8	CYP8	E
Cystathionase	CTH	E
Cystathione beta synthase	CBS	E
Cytidine deaminase	CDA	E
Cytidine-5-prime-triphosphate synthetase	CTPS	E
Cytochrome a		E
Cytochrome c		E
Cytochrome c oxidase, MTCO		E
Dihydrolipoamide branched chain transacylase	DBT	N
Dopamine beta hydroxylase	DBH	E
Dopamine receptors D1	DRD1	N
Dopamine receptors D2	DRD2	N
Dopamine receptors D3	DRD3	N
Dopamine receptors D4	DRD4	N
Dopamine receptors D5	DRD5	N
Doublecortin, DCX	DCX	S
Enolase	ENO1	E
Flightless-II, Drosophila homolog of	FLII	G
Fragile site, folic acid type, rare, fra(X) A	FRAXA	N
Fragile site, folic acid type, rare, fra(X) E	FRAXE	N
Fragile site, folic acid type, rare, fra(X) F	FRAXF	N
GABA receptor, alpha 1	GABRA1	N
GABA receptor, alpha 2	GABRA2	N
GABA receptor, alpha 3	GABRA3	N
GABA receptor, alpha 4	GABRA4	N
GABA receptor, alpha 5	GABRA5	N
GABA receptor, alpha 6	GABRA6	N
GABA receptor, beta 1	GABRB1	N
GABA receptor, beta 2	GABRB2	N
GABA receptor, beta 3	GABRB3	N
GABA receptor, gamma 1	GABRG1	N
GABA receptor, gamma 2	GABRG2	N
GABA receptor, gamma 3	GABRG3	N
Galactose 1-phosphate uridyl-transferase	GALT	E
Geniospasm 1	GSM1	G
Glutathione	GSH	T
Glutathione S-transferase, GSTZ1	GSTZ1	E
Glyceraldehyde-3-phosphate dehydrogenase, GAPDH	GAPDH	E

Glycerol kinase	GK	E
Glycinamide ribonucleotide (GAR) transformylase	GART	E
GM2 ganglioside activator protein, GM2A	GM2A	E
Gustducin, alpha (taste-specific G protein)	GDCA	N
Inositol monophosphatase	IMPA1	N
IP3 kinase		E
Mannosidase, beta A lysosomal	MANBA	E
Melatonin receptor 1A	MTNR1A	N
Melatonin receptor 1B	MTNR1B	N
Monoamine oxidase A	MAOA	E
Monoamine oxidase B	MAOB	E
Muscarinic receptor, M1	CHRM1	N
Muscarinic receptor, M2	CHRM2	N
Muscarinic receptor, M3	CHRM3	N
Muscarinic receptor, M4	CHRM4	N
Muscarinic receptor, M5	CHRM5	N
N-acetylglucosamine-6-sulfatase	GNS	E
NADPH-dependent cytochrome P450 reductase	POR	E
Neurokinin A	NKNA	N
Neurokinin B	NKNB	N
Neuropeptide Y	NPY	N
Neuropeptide Y receptor Y1	NPY1R	N
Neuropeptide Y receptor Y2	NPY2R	N
Neurotensin	NTS	N
Neurotensin receptor	NTSR1	N
Nitric oxide synthase 1, NOS1	NOS1	E
Nitric oxide synthase 2, NOS2	NOS2	E
Nitric oxide synthase 3, NOS3	NOS3	E
Ocular albinism 1	OA1	S
Opioid receptor, delta	OPRD1	N
Opioid receptor, kappa	OPRK1	N
Opioid receptor, mu	OPRM1	N
Orexin	OX	G
Orexin 1 receptor	OX1R	G
Orexin 2 receptor	OX2R	G
Phosphoglycerate kinase 1	PGK1	E
Potassium inwardly-rectifying channel J1	KCNJ1	N
Potassium voltage-gated channel E1	KCNE1	N
Potassium voltage-gated channel Q1	KCNQ1	N
Preproenkephalin	PENK	N
Preproglucagon	GCG;GLP1; GLP2	G
Prion protein	PRNP	N
Proline dehydrogenase	PRODH	E
Pro-melanin-concentrating hormone	PMCH	G
Proopiomelanocortin	POMC	N
Purine nucleoside phosphorylase	NP	E

RIGUI	RIGUI	G
Serotonin N-acetyltransferase	SNAT	E
Serotonin receptor, 5HT1A	HTR1A	N
Serotonin receptor, 5HT1B	HTR1B	N
Serotonin receptor, 5HT1C	HTR1C	N
Serotonin receptor, 5HT1D	HTR1D	N
Serotonin receptor, 5HT1E	HTR1E	N
Serotonin receptor, 5HT1F	HTR1F	N
Serotonin receptor, 5HT2A	HTR2A	N
Serotonin receptor, 5HT2B	HTR2B	N
Serotonin receptor, 5HT2C	HTR2C	N
Serotonin receptor, 5HT3	HTR3	N
Serotonin receptor, 5HT4	HTR4	N
Serotonin receptor, 5HT5	HTR5	N
Serotonin receptor, 5HT6	HTR6	N
Serotonin receptor, 5HT7	HTR7	N
Solute carrier family 18, member 3	SLC18A3	T
Solute carrier family 6 (GAMMA-AMINO-BUTYRIC ACID transporter), member 1	SLC6A1	T
Solute carrier family 6 (neurotransmitter transporter, dopamine), member 3	SLC6A3	T
Solute carrier family 6 (neurotransmitter transporter, noradrenaline), member 2	SLC6A2	T
Solute carrier family 6 (neurotransmitter transporter, serotonin), member 4	SLC6A4	T
Synapsin 1a & 1b	SYN1	N
Synapsin 2a & 2b	SYN2	N
Synaptogyrin		N
Synaptophysin	SYP	N
Synaptosomal-associated protein, 25KD	SNAP25	N
Syntaxin 1	STX1	N
Tachykinin receptor, NK1R	TACR1	N
Tachykinin receptor, NK2R	TACR2	N
Tachykinin receptor, NK3R	TACR3	N
Tau protein	MAPT	S
Tryptophan hydroxylase	TPH	E
Tyrosine hydroxylase	TH	E
Ubiquitin		G
Ubiquitin B	UBB	G
Ubiquitin C	UBC	G
UDP-glucuronosyltransferase 1	ugt1d, UGT1	E
UDP-glucuronosyltransferase 2	UGT2	E
Vacuolar proton pump, subunit 1	VPP1	N
Vacuolar proton pump, subunit 3	VPP3	N
Vasoactive intestinal polypeptide	VIP	N
Vasoactive intestinal polypeptide receptor	VIPR	N

In a fifth aspect.

## BRAIN INJURY

The present invention relates to a method of assessing the consequences and complications and the many symptoms arising as a result of sustaining brain damage.

The brain is one of the most complex organs in the body. Composed of nerve and support cells it is the substrate for cognition, behaviour and the formulation and execution of planned actions. The constant activity of brain cells ensures that the brain is one of the most energy and oxygen dependant organs in the body. Interruptions to the flow of oxygen or nutrients even for brief periods can result in damage to cells and long fibre tracts. Furthermore, the physical structure of the brain within the skull can also lead to vulnerability to damage. The brain is suspended in cerebro-spinal fluid (CSF), enclosed in a fixed rigidly confined space, the skull, and its closely applied tough, inelastic connective tissue, the dura matter. As such the finite space within the brain case has significant consequences for brain function when events occur which result in the available space being occupied by for example, tumour growth, or the accumulation of blood following a traumatic injury.

### **Hypoxia and Ischemic Lesions:**

The brain is very sensitive both to global (hypoxia) and local (ischemia) reductions in blood and oxygen supply. Although the terms hypoxia and ischemia are used interchangeably, these conditions have different pathophysiology and consequences.

- Hypoxia: the blood flow to the CNS may be entirely normal or even increased. The greatest damage is caused in certain populations of neurones that are particularly vulnerable to hypoxia.
- Local brain ischemia: usually due to arterial stenosis or occlusion, any infarction is within the perfusion territory of the affected artery.
- Global brain ischemia: usually occurs when systemic blood pressure falls very low. Examples of causes include; cardiac tamponade, heroin overdose or intracranial pressure rises to a level that restricts perfusion of the brain e.g. after a head injury.

In practice, many causes of hypoxia (e.g. respiratory arrest or carbon monoxide poisoning) also depress cardiac output and so produce a combination of hypoxic and global ischemic brain injury. Common causes of hypoxia are , carbon monoxide poisoning, near drowning, respiratory arrest or prolonged status epilepticus. Common causes of ischaemia are cardiac arrest with prolonged asystole, hypotension due to myocardial infarction, cardiac tamponade, or major cardiac dysrhythmia, intraoperative hypotensive episode(s) or severe increases in intracranial pressure (Ellison D., Love S. *et al*,1998).

### **Vascular Disease and Infarcts.**

An infarct is defined as an area in the brain tissue in which all cellular elements undergo necrosis (cell death), usually as a result of a cessation of flow of oxygenated blood to the region.



The clinical term 'stroke' describes a syndrome of sudden onset, non-epileptic, neurologic deficit that lasts more than 24 hours. Stroke has come to mean either brain infarction or haemorrhage.

Infarcts can be caused by:

- Large vessel or macrovascular (arterial) disease
- Small vessel or microvascular (arterial) disease
- Emboli
- Venous thrombosis

Strokes are worldwide in distribution and are common in the elderly, killing 150,000 Americans, making it the third leading cause of death in the USA. Twenty percent of strokes are haemorrhagic, resulting in bleeding into the brain. Ischaemic strokes, occurring when blood clots obstruct blood flow in vessels supplying blood to the brain, account for the remainder (Gunel M. and Lifton R.P, 1996).

Atherosclerosis is by far the leading systemic vasculopathy that produces brain infarcts, especially in older patients. It can affect both intracranial and extracranial large arteries. The major risk factors for Atherosclerosis include: age, family history, diabetes mellitus, cigarette smoking, hypertension and obesity.

Other large vessel diseases include; fibromuscular dysplasia (FMD), Moyamoya disease, arterial dissection, HIV associated arteriopathies, cerebrovascular disease associated with antiphospholipid antibodies, angiitis and vascular affecting large arteries, giant cell arteritis and Takayasu's arteritis.

Small vessels in the brain can also be affected by arteriosclerosis, lipohyalinosis and amyloid angiopathy.

An 'embolic' stroke may result when any solid material forms within the arterial circulation, is introduced into the arterial circulation or forms in the venous circulation. Sources of brain emboli include atheroma, cardiogenic emboli (associated with cardiac pathology particularly in young people who are relatively free of Atherosclerosis), fat (often associated with fractures of long bones or the pelvis), neoplasm's and parasites or iatrogenic causes (e.g. air embolism can occur in decompression sickness and cardiac bypass surgery).

Cerebral venous thrombosis (CVT) is a much less common cause of stroke than arterial disease and causes include: infections (either intracranial or in adjacent facial and bony structures), head injury, neurosurgical procedures and neoplasm's.

The main causes of infarcts are mentioned above but twenty percent of strokes are haemorrhagic. The intracranial haemorrhage that occurs is the extravasation of blood into brain substance. Conditions associated with brain haemorrhage are; hypertension, trauma, cerebral amyloid angiopathy, berry aneurysm, vascular malformations, bleeding diathesis, illicit drug use, neoplasm's, infection and adverse events following drug or surgical interventions

**Trauma:**

Head injury, whether accidental, criminal, or suicidal, is the leading cause of death in people less than 45 years of age in developed countries. In the USA, an estimated 700,000 individuals each year sustain a severe head injury. Improvements in the acute management of trauma have led to an increase in the number of disabled survivors.

There are two main categories of head injury type, these are; non-missile or blunt head injury (the most common that is seen clinically) and missile head injury. The lesions that result can be divided according to their distribution i.e. focal or diffuse.

Focal lesions of the brain may lead to contusions, lacerations, haemorrhage or infection.

Diffuse brain damage is accounted for by the phenomena of diffuse axonal injury, diffuse vascular injury, raised intracranial pressure and ischaemic damage.

Particular groups of neurones or cells may be vulnerable to the additional processes of necrosis or apoptosis as a result of the pathological processes set in train by the brain injury.

**Infection and Degeneration**

Each of the above types of damage can also be caused by infections (e.g. HIV, rabies, prion disease, malarial parasites) or degenerative disease (e.g. Huntington chorea, Parkinson's disease, multiple sclerosis, dementia's).

**CONSEQUENCES OF BRAIN INJURY**

Brain damage due to disease or injury causes a range of reactions at a cellular level; neurone death, axonal degeneration, nuclear inclusions, neuronal cytoplasmic inclusions, structural abnormalities of axons, pathologic responses in astrocytes and microglia, inclusions in ependymal cells and choroid plexus epithelium and brain mineralization.

The long-term effects of brain injury result from the very limited capacity for repair and regrowth of these brain structures and the location and extent of the injury. Necrosis of several cubic centimetres of brain tissue may be clinically silent in the frontal lobe, severely disabling in the spinal cord, or fatal in the brain stem. The magnitude and distribution of the traumatic brain lesion obviously depend on the shape of the object causing the trauma, the force of the impact, and whether the head is in motion at the time of injury. Severe brain damage can occur in the absence of external signs of head injury, and conversely, severe lacerations and even skull fractures do not necessarily indicate damage to the underlying brain.

Brain injury is a very variable clinical entity and whilst many patients can make a good recovery from moderate head injuries or strokes a degree of residual deficit is common.

The actual range of deficits is very wide and encompasses a series of debilitating symptoms such as epilepsy, paralysis, blindness, deafness, dementia, psychiatric or

behavioural disturbances, personality and IQ changes to a persistent vegetative state (Gelder et al 1996, Lishman 1997). In addition the presence of a previous injury can confer additional vulnerabilities to the brain function of a person should they sustain experience any future incident of brain damage whether due to disease, trauma, infection or developmental anomaly.

Recent advances in neuroscience have begun to highlight new therapeutic approaches to treating brain injury. Treatment of ischaemic stroke with thrombolytic agents has recently showed modest benefit, but it underscores the importance of disease prevention for long term reduction in morbidity and mortality. The importance of hypertension in stroke pathogenesis has been shown by large prospective trials, demonstrating that treatment of hypertension reduces the risk of stroke by 40% (MacMahon et al., 1990). These observations raise the possibility that genetic predisposition may be important in the pathogenesis of stroke. Such predisposition may not only include genes contributing to elevated blood pressure but also genes acting independently of blood pressure.

Due to extremely limited regeneration of this tissue, long term clinical improvement following a stroke is minimal, commonly leaving stroke survivors with life-long disability. This high toll has a large economic and social impact on public health, with an estimated annual cost of stroke in the USA of \$30 billion.

More recent developments have included the concept of neuroprotection in the treatment of acute or chronic neurological disorders. An example of this is the research into glutamate, which suggests that raised levels of glutamate in the brain is potential neurotoxic and that glutamate antagonists can be neuroprotective. Many glutamate antagonists are currently under clinical evaluation in the treatment of stroke, head or spinal cord injury. Unfortunately, most of them currently have serious, largely behavioural side effects.

Side effects of treatments given for brain injury are of course undesirable, as in the case of glutamate antagonists, but more effective treatment will only become available when an understanding of the processes of brain damage and affect it has on the individual becomes clearer.

We have elaborated on the value and utility to be derived from the gathering together of the genes which form the core gene list for this particular Genostic system.

These genes are elaborated below:

#### KEY TO 'PROTEIN FUNCTION' COLUMN

- E ENZYME
- T TRANSPORT & STORAGE
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- I IMMUNITY
- N NERVOUS TRANSMISSION
- G GROWTH & DIFFERENTIATION

**BRAIN INJURY GENE LIST**

	<b>HUGO symbol</b>	<b>Protein function</b>
2,3-bisphosphoglycerate mutase	BPGM	E
3 beta hydroxysteroid dehydrogenase 2	HSD3B2	E
4-hydroxyphenylpyruvate dioxygenase	HPD	E
5,10-methylenetetrahydrofolate reductase (NADPH)	MTHFR	E
6-pyruvoyltetrahydropterin synthase	PTS	E
Acetoacetyl 2-CoA-thiolase	ACAT2	E
Acetyl CoA acyltransferase	ACAA	E
Acetylcholine receptor, nicotinic, alpha A1	CHRNA1	N
Acetylcholine receptor, nicotinic, alpha A2	CHRNA2	N
Acetylcholine receptor, nicotinic, alpha A3	CHRNA3	N
Acetylcholine receptor, nicotinic, alpha A4	CHRNA4	N
Acetylcholine receptor, nicotinic, alpha A5	CHRNA5	N
Acetylcholine receptor, nicotinic, alpha A6	CHRNA6	N
Acetylcholine receptor, nicotinic, alpha A7	CHRNA7	N
Acetylcholine receptor, nicotinic, beta 1	CHRNA1	N
Acetylcholine receptor, nicotinic, beta 2	CHRNA2	N
Acetylcholine receptor, nicotinic, beta 3	CHRNA3	N
Acetylcholine receptor, nicotinic, beta 4	CHRNA4	N
Acetylcholine receptor, nicotinic, epsilon	CHRNA5	N
Acetylcholine receptor, nicotinic, gamma	CHRNA6	N
Acetylcholinesterase	ACHE	E
Adducin, alpha	ADD1	S
Adducin, beta	ADD2	S
Adenosine receptor A1	ADORA1	N
Adenosine receptor A2A	ADORA2A	N
Adenosine receptor A2B	ADORA2B	N
Adenosine receptor A3	ADORA3	N
Adenylate cyclase 1	ADCY1	E
Adenylate cyclase 2	ADCY2	E
Adenylate cyclase 3	ADCY3	E
Adenylate cyclase 4	ADCY4	E
Adenylate cyclase 5	ADCY5	E
Adenylate cyclase 6	ADCY6	E
Adenylate cyclase 7	ADCY7	E
Adenylate cyclase 8	ADCY8	E
Adenylate cyclase 9	ADCY9	E
Adrenergic receptor, alpha1	ADRA1	N
Adrenergic receptor, alpha2	ADRA2	N
Adrenergic receptor, beta1	ADRB1	N
Adrenergic receptor, beta2	ADRB2	N
Adrenergic receptor, beta3	ADRB3	N
Adrenocorticotrophic hormone (ACTH) receptor	ACTHR	G
Albumin, ALB	ALB	T

Aldehyde dehydrogenase 10	ALDH10	E
Aldosterone receptor	MLR	G
Alpha 1 acid glycoprotein	AAG; AGP	T
Alpha 2 macroglobulin	A2M	I
alpha thalassemia gene	ATRX	N
alpha1-antitrypsin	PI	E
alpha2-antiplasmin	PLI	E
alpha-synuclein	SNCA	N
Aminomethyltransferase	AMT	E
Aminopeptidase P	XPNPEP2	E
Amyloid beta (A4) precursor protein-binding, APBB1	APBB1	N
Amyloid beta A4 precursor protein	APP	N
Amyloid beta A4 precursor-like protein	APLP	N
Angiopoietin 1	ANGPT1	G
Angiopoietin 2	ANGPT2	G
Angiotensin converting enzyme	ACE, DCP1	E
Angiotensin receptor 1	AGTR1	T
Angiotensin receptor 2	AGTR2	T
Angiotensinogen	AGT	E
Annexin 1	ANX 1	I
Antidiuretic hormone receptor	ADHR	T
Antithrombin III	AT3	E
Apolipoprotein A I	APOA1	T
Apolipoprotein A II	APOA2	T
Apolipoprotein B	APOB	T
Apolipoprotein C1	APOC1	T
Apolipoprotein C2	APOC2	T
Apolipoprotein C3	APOC3	T
Apolipoprotein D	APOD	T
Apolipoprotein E	APOE	T
Apolipoprotein H	APOH	T
Apoptosis antigen 1	APT1	I
Arginase	ARG1	E
Arginine vasopressin	AVP	N
Arginine vasopressin receptor 1A	AVPR1A	N
Arginine vasopressin receptor 1B	AVPR1B	N
Arginine vasopressin receptor 2	AVPR2	N
Arginosuccinate lyase	ASL	E
Arginosuccinate synthetase	ASS	E
Arylsulfatase A	ARSA	E
Arylsulfatase D	ARSD	E
Arylsulfatase E	ARSE	E
Arylsulfatase F	ARSF	E
Aspartoacylase	ASPA	E
Ataxia telangiectasia gene, AT	ATM	G
Atrial natriuretic peptide	ANP	G
Atrial natriuretic peptide receptor A	NPR1	G

Atrial natriuretic peptide receptor B	NPR2	G
Atrial natriuretic peptide receptor C	NPR3	G
Bagpipe homeobox, drosophila homolog of, 1	BAPX1	G
beta-synuclein	SNCB	N
Bleomycin hydrolase	BLMH	E
Bradykinin receptor B1		I
Bradykinin receptor B2		I
Brain derived neurotrophic factor	BDNF	G
Brain derived neurotrophic factor (BDNF) receptor	BDNFR	G
Butyrylcholinesterase	BCHE	E
Ca(2+) transporting ATPase, slow twitch	ATP2A2	T
Cadherin E	CDH1	G
Cadherin EP		G
Cadherin N	CDH2	G
Cadherin P	CDH3	G
Calbindin 1	CALB1	G
Calbindin D9K	CALB3	G
Calcineurin A1	CALNA1	I
Calcineurin A2	CALNA2	I
Calcineurin A3	CALNA3	I
Calcineurin B		I
Calcitonin/Calcitonin gene-related peptide alpha	CALCA	N
Calcium channel, voltage-dependent, alpha 1F subunit	CACNA1F	N
Calcium channel, voltage-dependent, Alpha-1B (CACNL1A5)	CACNA1B	N
Calcium channel, voltage-dependent, Alpha-1C	CACNA1C	N
Calcium channel, voltage-dependent, Alpha-1D	CACNA1D	N
Calcium channel, voltage-dependent, Alpha-1E (CACNL1A6)	CACNA1E	N
Calcium channel, voltage-dependent, Alpha-2/delta	CACNA2	N
Calcium channel, voltage-dependent, Beta 1	CACNB1	N
Calcium channel, voltage-dependent, Beta 3	CACNB3	N
Calcium channel, voltage-dependent, L type, alpha 1S subunit	CACNA1S	N
Calcium channel, voltage-dependent, Neuronal, Gamma	CACNG2	N
Calcium channel, voltage-dependent, P/Q type, alpha 1A subunit	CACNA1A	N
Calcium channel, voltage-dependent, T-type		N
Calmodulin 1	CALM1	G
Calmodulin 2	CALM2	G
Calmodulin 3	CALM3	G

Calmodulin-dependant protein kinase II	CAMK2A	G
Calnexin	CANX	G
Calpain	CAPN, CAPN3	E
Calretinin	CALB2	N
Carbonic anhydrase 3	CA3	E
Carbonic anhydrase 4	CA4	E
Carbonic anhydrase, alpha	CA1	E
Carbonic anhydrase, beta	CA2	E
Cardiac-specific homeobox, CSX	CSX	G
Carnosinase		N
Caspase 1	CASP1	G
Caspase 10	CASP10	G
Caspase 2	CASP2	G
Caspase 3	CASP3	G
Caspase 4	CASP4	G
Caspase 5	CASP5	G
Caspase 6	CASP6	G
Caspase 7	CASP7	G
Caspase 8	CASP8	G
Caspase 9	CASP9	G
Catechol-O-methyltransferase	COMT	E
CD1	CD1	I
CD4	CD4	I
Cell adhesion molecule, intercellular, ICAM	ICAM1	G
Cell adhesion molecule, leukocyte- endothelial, LECAM (CD62)	LECAM1	G
Cell adhesion molecule, liver, LCAM	LCAM	G
Cell adhesion molecule, neural, NCAM1	NCAM1	G
Cell adhesion molecule, neural, NCAM120	NCAM120	G
Cell adhesion molecule, neural, NCAM2	NCAM2	G
Cell adhesion molecule, platelet-endothelial, PECAM	PECAM1	G
Cell adhesion molecule, vascular, VCAM	VCAM1	G
Ceroid lipofuscinosis neuronal 2	CLN2	N
Ceroid lipofuscinosis neuronal 3	CLN3	N
Ceroid lipofuscinosis neuronal 4	CLN4	N
Ceroid lipofuscinosis neuronal 5	CLN5	N
Ceroid lipofuscinosis neuronal 6	CLN6	N
Chemokine receptor CXCR4	CXCR4	I
Choline acetyltransferase	CHAT	E
Chymotrypsinogen		E
Cockayne syndrome gene, CKN1	CKN1	G
Cofilin		S
Collagen I alpha 1	COL1A1	S
Collagen I alpha 2	COL1A2	S
Collagen II alpha 1	COL2A1	S
Collagen III alpha 1	COL3A1	S
Collagen IV alpha 1	COL4A1	S

Collagen IV alpha 2	COL4A2	S
Collagen IV alpha 3	COL4A3	S
Collagen IV alpha 4	COL4A4	S
Collagen IV alpha 5	COL4A5	S
Collagen IV alpha 6	COL4A6	S
Collagen IX alpha 2	COL9A2, EDM2	S
Collagen IX alpha 3	COL9A3	S
Collagen receptor	COLR	S
Collagen V alpha 1	COL5A1	S
Collagen V alpha 2	COL5A2	S
Collagen VI alpha 1	COL6A1	S
Collagen VI alpha 2	COL6A2	S
Collagen VI alpha 3	COL6A3	S
Collagen VII alpha 1	COL7A1	S
Collagen X alpha 1	COL10A1	S
Collagen X alpha 1	COL11A1	S
Collagen XI alpha 2	COL11A2	S
Collagen XVII alpha 1	COL17A1	S
Corticotrophin-releasing hormone	CRH	T
Corticotrophin-releasing hormone receptor	CRHR1	T
Creb binding protein	CREBBP	G
Cu <sup>2+</sup> transporting ATPase beta polypeptide	ATP7B	E
Cyclic AMP-dependent protein kinase	PKA	E
Cyclic nucleotide phosphodiesterase 2A3	PDE2A3	E
Cyclic nucleotide phosphodiesterase 3A	PDE3A	E
Cyclic nucleotide phosphodiesterase 3B	PDE3B	E
Cyclic nucleotide phosphodiesterase 4A	PDE4A	E
Cyclic nucleotide phosphodiesterase 4C	PDE4C	E
Cyclic nucleotide phosphodiesterase 5A	PDE5A	E
Cyclic nucleotide phosphodiesterase 6A	PDE6A	E
Cyclic nucleotide phosphodiesterase 6B	PDE6B	E
Cyclic nucleotide phosphodiesterase 7	PDE7	E
Cyclic nucleotide phosphodiesterase 8	PDE8	E
Cyclic nucleotide phosphodiesterase 9A	PDE9A	E
Cyclooxygenase 1	COX1	E
Cyclooxygenase 2	COX2	E
CYP11A1	CYP11A1	E
CYP11B1	CYP11B1	E
CYP11B2	CYP11B2	E
CYP17	CYP17	E
CYP19	CYP19	E
CYP1A1	CYP1A1	E
CYP1A2	CYP1A2	E
CYP1B1	CYP1B1	E
CYP21	CYP21	E
CYP24	CYP24	E
CYP27	CYP27	E
CYP27B1	PDDR	E



CYP2A1	CYP2A1	E
CYP2A13	CYP2A13	E
CYP2A3	CYP2A3	E
CYP2A6V2	CYP2A6V2	E
CYP2A7	CYP2A7	E
CYP2B6	CYP2B6	E
CYP2C18	CYP2C18	E
CYP2C19	CYP2C19	E
CYP2C8	CYP2C8	E
CYP2C9	CYP2C9	E
CYP2D6	CYP2D6	E
CYP2E1	CYP2E1	E
CYP2F1	CYP2F1	E
CYP2J2	CYP2J2	E
CYP3A3	CYP3A3	E
CYP3A4	CYP3A4	E
CYP3A5	CYP3A5	E
CYP3A7	CYP3A7	E
CYP4A11	CYP4A11	E
CYP4B1	CYP4B1	E
CYP4F2	CYP4F2	E
CYP4F3	CYP4F3	E
CYP51	CYP51	E
CYP5A1	CYP5A1	E
CYP7A	CYP7A	E
CYP8	CYP8	E
Cystatin B	CSTB	T
Cystatin C	CST3	T
Cytidine-5-prime-triphosphate synthetase	CTPS	E
Cytochrome a		E
Cytochrome c		E
Cytochrome c oxidase, MTCO		E
Cytokine-suppressive antiinflammatory drug-binding protein 1	CSBP1	I
Cytokine-suppressive antiinflammatory drug-binding protein 2	CSBP2	I
DAX1 nuclear receptor	DAX1	I
Deleted in malignant brain tumours 1	DMBT1	G
Delta-7-dehydrocholesterol reductase	DHCR7	E
Dihydrolipoamide branched chain transacylase	DBT	N
Dihydroxyacetonephosphate acyltransferase	DHAPAT	E
Dopamine beta hydroxylase	DBH	E
Dopamine receptors D1	DRD1	N
Dopamine receptors D2	DRD2	N
Dopamine receptors D3	DRD3	N
Dopamine receptors D4	DRD4	N
Dopamine receptors D5	DRD5	N

Dystonia 9	CSE	S
Dystrophia myotonica	DM, DMPK	E
Dystrophia myotonica, atypical	DM2	E
Dystrophin	DMD	S
Ectodermal Dysplasia 1 gene	ED1	S
Empty spiracles (drosophila) homologue 1	EMX1	G
Empty spiracles (drosophila) homologue 2	EMX2	G
Endothelin 1	EDN1	N
Endothelin 2	EDN2	N
Endothelin 3	EDN3	N
Endothelin converting enzyme	ECE1	N
Endothelin receptor type A	EDNRA	N
Endothelin receptor type B	EDNRB	N
Enolase	ENO1	E
Epidermal growth factor	EGF	G
Epidermal growth factor receptor	EGFR	G
Epilepsy, benign neonatal 4 gene	ICCA	E
Epilepsy, female restricted	EFMR	E
Epilepsy, progressive myoclonic 2 gene	EPM2A	E
Excision repair complementation group 4 protein	ERCC4	E
Factor 1 (No. one)	F1	I
Factor III	F3	I
Factor IX	F9	I
Factor V	F5	I
Factor VII	F7	I
Factor VIII	F8	I
Factor X	F10	I
Factor XI	F11	I
Factor XII	F12	I
Factor XIII A & B	F13A & F13B	I
Fanconi anemia, complementation group C	FANCC	T
Fanconi anemia, complementation group D	FANCD	T
Fibrinogen alpha	FGA	S
Fibrinogen beta	FGB	S
Fibrinogen gamma	FGG	S
Fibroblast growth factor	FGF1	G
Fibroblast growth factor receptor 1	FGFR1	G
Fibroblast growth factor receptor 2	FGFR2	G
Fibroblast growth factor receptor 3	FGFR3	G
Fibronectin precursor	FN1	G
Flightless-II, Drosophila homolog of	FLII	G
Follicle stimulating hormone receptor	FSHR, ODG1	G
Follicle stimulating hormone, FSH	FSHB	G
Formiminotransferase		E
Fragile site, folic acid type, rare, fra(X) A	FRAXA	N
Fragile site, folic acid type, rare, fra(X) E	FRAXE	N
Fragile site, folic acid type, rare, fra(X) F	FRAXF	N

Frataxin	FRDA	G
Fukuyama type congenital muscular dystrophy	FCMD	G
Fumarase	FH	E
GABA receptor, alpha 1	GABRA1	N
GABA receptor, alpha 2	GABRA2	N
GABA receptor, alpha 3	GABRA3	N
GABA receptor, alpha 4	GABRA4	N
GABA receptor, alpha 5	GABRA5	N
GABA receptor, alpha 6	GABRA6	N
GABA receptor, beta 1	GABRB1	N
GABA receptor, beta 2	GABRB2	N
GABA receptor, beta 3	GABRB3	N
GABA receptor, gamma 1	GABRG1	N
GABA receptor, gamma 2	GABRG2	N
GABA receptor, gamma 3	GABRG3	N
GABA transaminase	ABAT	E
Galactosyltransferase 1	GT1	G
Galactosyltransferase, alpha 1,3	GGTA1	G
Galactosyltransferase, beta 3	B3GALT	G
Galanin	GAL	N
Galanin receptor	GALNR1	N
Gamma-glutamyltransferase 1	GGT1	T
Gastric Intrinsic factor, GIF	GIF	E
GDP dissociation inhibitor 1	GDI1	G
Glial-cell derived neurotrophic factor (GDNF) receptor		N
Glial-cell derived neurotrophic factor, GDNF	GDNF	N
Glioma chloride ion channel, GCC		G
Glutamate decarboxylase, GAD	GAD1	E
Glutamate receptor 1	GLUR1	N
Glutamate receptor 2	GLUR2	N
Glutamate receptor 3	GLUR3	N
Glutamate receptor 4	GLUR4	N
Glutamate receptor 5	GLUR5	N
Glutamate receptor 6	GLUR6	N
Glutamate receptor 7	GLUR7	N
Glutamate receptor, ionotropic, NMDA 1	NMDAR1	N
Glutamate receptor, ionotropic, NMDA 2A	NMDAR2A	N
Glutamate receptor, ionotropic, NMDA 2B	NMDAR2B	N
Glutamate receptor, ionotropic, NMDA 2C	NMDAR2C	N
Glutamate receptor, ionotropic, NMDA 2D	NMDAR2D	N
Glutaryl-CoA dehydrogenase	GCDH	E
Glutathione	GSH	T
Glutathione S-transferase, GSTZ1	GSTZ1	E
Glutathione synthetase	GSS	E
Glyceraldehyde-3-phosphate dehydrogenase, GAPDH	GAPDH	E

Glycerol kinase	GK	E
Glycinamide ribonucleotide (GAR) transformylase	GART	E
Glycine dehydrogenase	GLDC	E
GM2 ganglioside activator protein, GM2A	GM2A	E
Gonadotropin releasing hormone receptor	GNRHR	G
GTP cyclohydrolase 1	GCH1	G
Guanine nucleotide-binding protein, alpha activating activity polypeptide, GNAO	GNAO1	N
Guanylate cyclase 2D, membrane (retina- specific)	GUCY2D	E
Guanylate cyclase activator 1A (retina)	GUCA1A	E
Guanylyl cyclase		E
Haeme regulated inhibitor kinase		E
Haemoglobin alpha 1	HBA1	T
Haemoglobin alpha 2	HBA2	T
Haemoglobin beta	HBB	T
Haemoglobin delta	HBD	T
Haemoglobin gamma A	HBG1	T
Haemoglobin gamma B	HBG2	T
Haemoglobin gamma G	HBG3	T
Heparan sulfamidase		E
Heparin binding epidermal growth factor	HBEGF	G
Heparin Cofactor II	HCF2	I
Hepatic lipase	LIPC	E
Hexosaminidase A	HEXA,TSD	E
Hexosaminidase B	HEXB	E
Histamine receptors, H1		N
Histamine receptors, H2		N
Histamine receptors, H3		N
Histidase		E
HLA-B associated transcript 1	BAT1	I
HMG-CoA reductase	HMGCR	E
Holocarboxylase synthetase	HLCS	E
Holoprosencephaly 1	HPE1	G
Holoprosencephaly 2	HPE2	G
Holoprosencephaly 3	HPE3	G
Holoprosencephaly 4	HPE4	G
Hypoxia inducible factor 1	HIF1A	E
Hypoxia inducible factor 2		E
IC7 A and B		I
Inositol 1,4,5-triphosphate receptor 1	ITPR1	G
Inositol monophosphatase	IMPA1	N
Insulin	INS	G
Insulin receptor	INSR	G
Insulin-like growth factor 1	IGF1	G
Insulin-like growth factor 1 receptor	IGF1R	G
Insulin-like growth factor 2	IGF2	G

Insulin-like growth factor 2 receptor	IGF2R	G
Integrin beta 1	ITGB1	G
Integrin beta 2	ITGB2	G
Integrin beta 3	ITGB3	G
Integrin beta 4	ITGB4	G
Integrin beta 5	ITGB5	G
Integrin beta 6	ITGB6	G
Integrin beta 7	ITGB7	G
Integrin, alpha 1	ITGA1	G
Integrin, alpha 2	ITGA2	G
Integrin, alpha 3	ITGA3	G
Integrin, alpha 4	ITGA4	G
Integrin, alpha 5	ITGA5	G
Integrin, alpha 6	ITGA6	G
Integrin, alpha 7	ITGA7	G
Integrin, alpha 8	ITGA8	G
Integrin, alpha 9	ITGA9	G
Integrin, alpha M	ITGAM	G
Integrin, alpha X	ITGAX	G
Inter-alpha-trypsin inhibitor, IATI		E
Interleukin(IL) 1 receptor	IL1R	I
Interleukin(IL) 1, alpha	IL1A	I
Interleukin(IL) 1, beta	IL1B	I
Interleukin(IL) 10	IL10	I
Interleukin(IL) 10 receptor	IL10R	I
Interleukin(IL) 11	IL11	I
Interleukin(IL) 11 receptor	IL11R	I
Interleukin(IL) 12	IL12	I
Interleukin(IL) 12 receptor, beta 1	IL12RB1	I
Interleukin(IL) 13	IL13	I
Interleukin(IL) 13 receptor	IL13R	I
Interleukin(IL) 2	IL2	I
Interleukin(IL) 2 receptor, alpha	IL2RA	I
Interleukin(IL) 2 receptor, gamma	IL2RG	I
Interleukin(IL) 3	IL3	I
Interleukin(IL) 3 receptor	IL3R	I
Interleukin(IL) 4	IL4	I
Interleukin(IL) 4 receptor	IL4R	I
Interleukin(IL) 5	IL5	I
Interleukin(IL) 5 receptor	IL5R	I
Interleukin(IL) 6	IL6	I
Interleukin(IL) 6 receptor	IL6R	I
Interleukin(IL) 7	IL7	I
Interleukin(IL) 7 receptor	IL7R	I
Interleukin(IL) 8	IL8	I
Interleukin(IL) 8 receptor	IL8R	I
Interleukin(IL) 9	IL9	I
Interleukin(IL) 9 receptor	IL9R	I

Interleukin(IL) receptor antagonist 1	IL1RN, IL1RA	I
IP3 kinase		E
Kallikrein 3	KAK3	I
Kininogen, High molecular weight	KNG	I
Kynureninease		E
Laminin 5, alpha 3	LAMA3	G
Laminin 5, beta 3	LAMB3	G
Laminin 5, gamma 2	LAMC2	G
Laminin M	LAMM	G
Laminin receptor 1	LAMR1	G
Latent transforming growth factor-beta binding protein 2	LTBP2	G
Leptin	LEP	G
Leptin receptor	LEPR	G
Leukin		I
Leukocyte-specific transcript 1	LST-1	I
Leukotriene A4 hydrolase		I
Leukotriene A4 synthase	LTA4S	E
Leukotriene B4 receptor		I
Leukotriene B4 synthase	LTB4S	E
Leukotriene C4 receptor		I
Leukotriene C4 synthase	LTC4S	E
Leukotriene D4/E4 receptor		I
LIM homeobox protein 1	LHX1	G
LIM-Kinase I (LINK-I)		I
Lipocortin 1	ANX4	I
Lipoprotein lipase	LPL	I
Lipoprotein receptor, Low Density	LDLR	T
Lipoprotein, High Density	HDLDT1	T
Lipoprotein, Intermediate Density		T
Lipoprotein, Low Density 1		T
Lipoprotein, Low Density 2		T
Lipoprotein, Very Low Density	VLDLR	T
Lipoprotein-associated coagulation factor	LACI	I
Low density lipoprotein receptor-related protein precursor	LRP	T
Lymphoid enhancer-binding factor	LEF-1	G
MAD (mothers against decapentaplegic, Drosophila) homologue 4	MADH4	G
Malonyl CoA decarboxylase		E
Mannosidase, alpha B lysosomal	MANB	E
Mannosidase, beta A lysosomal	MANBA	E
Methionine synthase	MTR	E
Methylmalonyl-CoA mutase	MUT	E
Mevalonate kinase	MVK	E
Mismatch repair gene, PMSL2	PMS2	G
Molybdenum cofactor synthesis 1	MOCS1	E
Molybdenum cofactor synthesis 2	MOCS2	E

Monoamine oxidase A	MAOA	E
Monoamine oxidase B	MAOB	E
Mucopolidoses	GNPTA	E
Muscarinic receptor, M1	CHRM1	N
Muscarinic receptor, M2	CHRM2	N
Muscarinic receptor, M3	CHRM3	N
Muscarinic receptor, M4	CHRM4	N
Muscarinic receptor, M5	CHRM5	N
Myelin basic protein		S
N-acetylglucosamine-6-sulfatase	GNS	E
N-acetylglucosaminidase, alpha	NAGLU	E
NADPH-dependent cytochrome P450 reductase	POR	E
NB6		I
Nerve growth factor	NGF	G
Nerve growth factor receptor	NGFR	G
Neurite inhibitory protein		N
Neurofibromin 1	NF1	G
Neurofibromin 2	NF2	G
Neurofilament protein, NF125	NF150	S
Neurofilament protein, NF200	NF200	S
Neurofilament protein, NF68	NF68	S
Neurokinin A	NKNA	N
Neurokinin B	NKNB	N
Neuropeptide Y	NPY	N
Neuropeptide Y receptor Y1	NPY1R	N
Neuropeptide Y receptor Y2	NPY2R	N
Nitric oxide synthase 1, NOS1	NOS1	E
Nitric oxide synthase 2, NOS2	NOS2	E
Nitric oxide synthase 3, NOS3	NOS3	E
Notch 3	NOTCH3	G
Notch ligand - jagged 1	JAG1, AGS	G
Nuclear factor I-kappa-B-like gene	IKBL	I
Nucleoside diphosphate kinase-A	NDPKA	E
Oncogene bcl2		G
Oncogene sis	PDGFB	G
Ornithine delta-aminotransferase	OAT	E
Ornithine transcarbamoylase	OTC, NME1	E
Orthodenticle (Drosophila) homolog 1	OTX1	G
Orthodenticle (Drosophila) homolog 2	OTX2	G
Patched (Drosophila) homolog, PTCH	PTCH	G
Peroxisomal membrane protein 1	PXMP1	S
Peroxisomal membrane protein 3	PXMP3	T
Peroxisome biogenesis factor 1	PEX1	T
Peroxisome biogenesis factor 19	PEX19	T
Peroxisome biogenesis factor 6	PEX6	T
Peroxisome biogenesis factor 7	PEX7	T
Peroxisome receptor 1	PXR1	T

Persyn		S
Phosphoglucose isomerase	GPI	E
Phosphoglycerate kinase 1	PGK1	E
Phospholipase A2, group 10	PLA2G10	I
Phospholipase A2, group 1B	PLA2G1B	I
Phospholipase A2, group 2A	PLA2G2A	I
Phospholipase A2, group 2B	PLA2G2B	I
Phospholipase A2, group 4A	PLA2G4A	I
Phospholipase A2, group 4C	PLA2G4C	I
Phospholipase A2, group 5	PLA2G5	I
Phospholipase A2, group 6	PLA2G6	I
Phospholipase C alpha		I
Phospholipase C beta		I
Phospholipase C delta	PLCD1	I
Phospholipase C epsilon		I
Phospholipase C gamma	PLCG1	I
Phosphomannomutase 2	PMM2	G
Plasminogen	PLG	E
Plasminogen activator inhibitor 1	PAI1	E
Plasminogen activator inhibitor 2	PAI2	E
Plasminogen activator receptor, Urokinase	UPAR; PLAUR	S
Plasminogen activator, Tissue	PLAT; TPA	E
Plasminogen activator, Urokinase	UPA; PLAU	E
Platelet derived growth factor	PDGF	G
Platelet derived growth factor receptor	PDGFR	G
Platelet glycoprotein 1b, alpha	GP1BA	I
Platelet glycoprotein 1b, beta	GP1BB	I
Platelet glycoprotein 1b, gamma	GP1BG	I
Platelet glycoprotein IX	GP9	I
Platelet glycoprotein V	GP5	I
Platelet-activating factor acetylhydrolase 1B	PAFAH1B1 or LIS1	I
Platelet-activating factor acetylhydrolase 2	PAFAH2	I
Platelet-activating factor receptor	PAFR	I
Plectin 1	PLEC1	T
Polycystin 1	PKD1	T
Polycystin 2	PKD2	T
Potassium inwardly-rectifying channel J1	KCNJ1	N
Potassium voltage-gated channel E1	KCNE1	N
Potassium voltage-gated channel Q1	KCNQ1	N
Potassium voltage-gated channel Q2	KCNQ2	N
Potassium voltage-gated channel Q3	KCNQ3	N
POU domain, class 1, transcription factor 1 (Pit1)	POU1F1	G
Prekallikrein		I
Prion protein	PRNP	N
Procollagen N-protease		E
Proline dehydrogenase	PRODH	E



Proopiomelanocortin	POMC	N
Prostacyclin synthase		I
Prostaglandin 15-OH dehydrogenase	HGPD; PGDH	I
Prostaglandin D - DP receptor		I
Prostaglandin E1 receptor		I
Prostaglandin E2 receptor		I
Prostaglandin E3 receptor		I
Prostaglandin F - FP receptor		I
Prostaglandin I2 receptor		T
Prostaglandin IP receptor		I
Protective protein for beta-galactosidase	PPGB	E
Protein C	PROC	I
Protein C inhibitor	PCI	I
Protein kinase C, alpha	PRKCA	E
Protein kinase C, gamma	PRKCG	E
Protein kinase G		E
Protein phosphatase 1, regulatory (inhibitor) subunit 3	PPP1R3	E
Protein S	PROS1	I
Prothrombin precursor	F2	I
Purine nucleoside phosphorylase	NP	E
Pyrroline-5-carboxylate synthetase	PYCS	E
Pyruvate carboxylase	PC	E
Ras-G-protein	RAS	G
Renin	REN	E
Replication factor C	RFC2	E
RIGUI	RIGUI	G
S100 calcium-binding protein A1	S100A1	N
S100 calcium-binding protein A2	S100A2	N
S100 calcium-binding protein A3	S100A3	N
S100 calcium-binding protein A4	S100A4	N
S100 calcium-binding protein A5	S100A5	N
S100 calcium-binding protein A6	S100A6	N
S100 calcium-binding protein A7	S100A7	N
S100 calcium-binding protein A8	S100A8	N
S100 calcium-binding protein A9	S100A9	N
S100 calcium-binding protein B	S100B	N
S100 calcium-binding protein P	S100P	N
Secretase, alpha		N
Secretase, beta		N
Secretase, gamma		N
Selectin E	SELE	N
Selectin L	SELL	N
Selectin P	SELP	N
Serotonin N-acetyltransferase	SNAT	E
Serotonin receptor, 5HT1A	HTR1A	N
Serotonin receptor, 5HT1B	HTR1B	N
Serotonin receptor, 5HT1C	HTR1C	N

Serotonin receptor, 5HT1D	HTR1D	N
Serotonin receptor, 5HT1E	HTR1E	N
Serotonin receptor, 5HT1F	HTR1F	N
Serotonin receptor, 5HT2A	HTR2A	N
Serotonin receptor, 5HT2B	HTR2B	N
Serotonin receptor, 5HT2C	HTR2C	N
Serotonin receptor, 5HT3	HTR3	N
Serotonin receptor, 5HT4	HTR4	N
Serotonin receptor, 5HT5	HTR5	N
Serotonin receptor, 5HT6	HTR6	N
Serotonin receptor, 5HT7	HTR7	N
Sodium channel, non-voltage gated 1, alpha	SCNN1A	N
Sodium channel, non-voltage gated 1, beta	SCNN1B	N
Sodium channel, non-voltage gated 1, gamma	SCNN1G	N
Sodium channel, voltage-gated, type 1, beta polypeptide	SCN1B	N
Solute carrier family 1 (glutamate transporter), member 1	SLC1A1	T
Solute carrier family 1 (glutamate transporter), member 2	SLC1A2	T
Solute carrier family 12, member 1	SLC12A1	T
Solute carrier family 12, member 2	SLC12A2	T
Solute carrier family 12, member 3	SLC12A3	T
Solute carrier family 16 (monocarboxylate transporter), member 1	SLC16A1	T
Solute carrier family 16 (monocarboxylate transporter), member 7	SLC16A7	T
Solute carrier family 18, member 3	SLC18A3	T
Solute carrier family 2 (facilitated glucose transporter), member 1	SLC2A1	T
Solute carrier family 20, member 3	SLC20A3	T
Solute carrier family 5 (sodium/glucose transporter), member 1	SLC5A1	T
Solute carrier family 5 (sodium/glucose transporter), member 2	SLC5A2	T
Solute carrier family 5 (sodium/glucose transporter), member 5	SLC5A5	T
Solute carrier family 5, member 3	SLC5A3	T
Solute carrier family 6 (GAMMA-AMINOBTYRIC ACID transporter), member 1	SLC6A1	T
Solute carrier family 6 (neurotransmitter transporter, dopamine), member 3	SLC6A3	T
Solute carrier family 6 (neurotransmitter transporter, noradrenaline), member 2	SLC6A2	T
Solute carrier family 6 (neurotransmitter transporter, serotonin), member 4	SLC6A4	T

Solute carrier family 7(amino acid transporter), member 1	SLC7A1	T
Solute carrier family 7(amino acid transporter), member 2	SLC7A2	T
Solute carrier family 7(amino acid transporter), member 7	SLC7A7	T
Sphingomyelinase	SMPD1	E
Spinocerebellar ataxia 8 gene	SCA8	N
Steroid 5 alpha reductase 1	SRD5A1	E
Steroid 5 alpha reductase 2	SRD5A2	E
Substance P		N
Succinic semi-aldehyde dehydrogenase	ssadh	E
Sulfamidase	SGSH	G
Sulfite oxidase	SUOX	E
Superoxide dismutase 1	SOD1	E
Superoxide dismutase 3	SOD3	E
Surfeit 1	SURF1	G
Synapsin 1a & 1b	SYN1	N
Synapsin 2a & 2b	SYN2	N
Synaptic vesicle amine transporter	SVAT	N
Synaptobrevin 1	SYB1	N
Synaptobrevin 2	SYB2	N
Synaptogyrin		N
Synaptophysin	SYP	N
Synaptotagmin 1	SYT1	N
Synaptotagmin 2	SYT2	N
Syntaxin 1	STX1	N
Talin	TLN	G
Tau protein	MAPT	S
TEK, tyrosine kinase, endothelial	TEK	E
Telomerase protein component		E
Thrombin receptor	F2R	I
Thrombopoietin	THPO	G
Thromboxane A synthase 1	TBXAS1	I
Thromboxane A2	TXA2	I
Thromboxane A2 receptor	TBXA2R	I
Thyroxin-binding globulin	TBG	T
Topoisomerase I		E
Transforming growth factor, beta 2	TGFB2	G
Transforming growth factor, beta receptor 2	TGFBR2	G
Tuberous sclerosis 1	TSC1	G
Tuberous sclerosis 2	TSC2	G
Tumour necrosis factor (TNF) receptor associated factor 1	TRAF1	I
Tumour necrosis factor (TNF) receptor associated factor 2	TRAF2	I
Tumour necrosis factor (TNF) receptor associated factor 3	TRAF3	I

Tumour necrosis factor (TNF) receptor associated factor 4	TRAF4	I
Tumour necrosis factor (TNF) receptor associated factor 5	TRAF5	I
Tumour necrosis factor (TNF) receptor associated factor 6	TRAF6	I
Tumour necrosis factor alpha	TNFA	I
Tumour necrosis factor alpha receptor	TNFAR	I
Tumour necrosis factor beta	TNFB	I
Tumour necrosis factor beta receptor	TNFBR	I
Tumour protein p53	TP53, P53	G
Tumour protein p63	TP63	G
Tyrosine aminotransferase	TAT	E
Tyrosine hydroxylase	TH	E
Ubiquitin		G
Ubiquitin B	UBB	G
Ubiquitin C	UBC	G
Ubiquitin carboxyl-terminal esterase L1	UCHL1	G
UDP-glucuronosyltransferase 1	ugt1d, UGT1	E
UDP-glucuronosyltransferase 2	UGT2	E
Undulin 1	COL14A1	S
Uridinediphosphate(UDP)-galactose-4-epimerase	GALE	E
Uroporphyrinogen III synthase	UROS	E
Vacuolar proton pump, subunit 1	VPP1	N
Vacuolar proton pump, subunit 3	VPP3	N
Vasoactive intestinal polypeptide	VIP	N
Vasoactive intestinal polypeptide receptor	VIPR	N
Von Hippel-Lindau gene	VHL	G
Wolf-Hirschhorn syndrome candidate 1 gene	WHSC1	G
Xanthine dehydrogenase	XDH	E
Zinc finger protein 2	ZIC2	S

In a sixth aspect.

## DEMENTIA

The present invention relates to a method of assessing the risk of developing the degenerative processes and multiplicity of symptoms associated with dementia and dementing disorders.

Dementia and the associated non-cognitive symptomatology is a serious and growing problem. It affects 5% of people aged over 65 and 20% of those over 80. Changing demographics mean that the number of people affected by dementia is set to rise by 2-3% a year so that numbers of sufferers by the year 2020 will rise from 650,000 to 850,000 in the UK and from 3,000,000 to 5,000,000 in the USA.

Dementia is defined as a chronic generalised impairment of psychological functions. The characteristic feature of clinical impairment is a generalised cognitive impairment but there are significant changes in behaviour and mood the whole of which give a complex syndrome with considerable variation in the degree and type of symptomatology from patient to patient.

Dementia has been defined as a disease of the brain in which there is disturbance of intellectual functioning, usually of a chronic or progressive nature, with a compromising effect on at least three of the following:

- Memory
- Language
- Visual and spatial skills
- Emotion or personality
- Cognition.

The complex nature of the symptoms and their variability in different patients provide significant challenges for the effective clinical and psychological management of patients (Roberts et al 1993, Youdofsky and hales 1994, Gelder et al 1996, Lishman 1997) Youdofsky.

The causes of and molecular pathologies occurring in the processes leading to dementia are numerous – including such direct causes as Alzheimer's disease, prion disease, frontal lobe dementia, Lewy body disease, ischaemic brain injury, cerebrovascular disease, stroke, infection and head injury (Roberts et al 1993, Fig 1 a and b) or as adverse events following the use of drugs or surgical procedures (Walton, 1993, Roberts 1993, Gelsder et al 1996, Lishman, 1997, Brody. Larner and Minneman 1998).

### Causes of dementia

Dementia has been related to many causes and conditions:

- Degenerative brain diseases
- Vascular disease
- Space-occupying lesions

- Trauma
- Infection
- Epilepsy
- Metabolic disease
- Endocrine dysfunction
- Autoimmune disease
- Toxicity
- Vitamin deficiency.

Recently significant advances have been made in the understanding of the molecular pathology underlying many of the dementing disorders. Neurotransmitter deficits have been described and the key proteins involved in the disorders have been identified (e.g. amyloid precursor protein, presenilin1 and 2, prion protein, tau protein and alpha-synuclein). Treatments designed to slow down the neuronal loss characteristic of dementia are becoming available. Furthermore, drug therapies that target the essential processes that result in dementia are in development and offer hope of a preventive therapeutic approach in the future.

All these advances are expected to complicate the process of clinical management in order to ensure that the most efficacious treatments are provided at the appropriate time to the individuals who will benefit most.

The clinical challenge is to identify patients with early signs of dementia and refer them promptly so that a more accurate diagnosis of the specific type of dementia can be made while the illness is still in its infancy. Other than in patients with a strong family background of disease, the diagnostic process is generally one of exclusion;

#### **Alzheimer's disease**

Alzheimer's disease (AD) is the most common form of dementia accounting for nearly 50% of cases. AD is defined as the development of multiple cognitive deficits manifest by both memory impairment and one or more of the following:

- language impairment
- loss of visual and spatial skills
- impairment of recognition functions
- disturbance of executive functioning.

The cognitive deficits lead to significant impairment in social and occupational functioning and are represented by a significant decline from previous levels of functioning. The course of AD is characterized by gradual onset and continuing cognitive decline.

To confirm a diagnosis of AD, the following must be excluded:

- Other CNS conditions that can cause progressive deficit of memory and cognition (vascular disease, Parkinson's disease, Huntington's disease, subdural haematoma, normal pressure hydrocephalus, brain tumour, etc)
- Systemic conditions that are known to cause dementia (hypothyroidism, B<sub>12</sub> or folate deficiency, hypercalcaemia, neurosyphilis, HIV, etc)
- Substance or toxin -induced conditions.

In addition, the deficits must not occur exclusively during the course of a delirium and the disturbance must not be better accounted for by another psychiatric disorder.

### **Vascular dementia**

Vascular dementia is the only major cause of dementia that is both treatable and preventable. Identification and prompt treatment are therefore especially important. Pure vascular disease accounts for at least 20% of dementias and plays a contributory role in a further 20%. Almost any cause of cerebrovascular disease may result in dementia if sufficient cortex is infarcted and/or cerebral blood flow is substantially reduced.

Diagnosis of vascular dementia is a three-stage process. First, the dementia syndrome has to be confirmed, and then the cerebrovascular disease diagnosed. Finally, the relationship between the two needs to be identified. Characteristics of vascular dementia include:

- Onset of dementia within three months of a stroke
- History of abrupt cognitive decline
- Fluctuating mental changes, with forgetfulness, impaired concentration, emotional lability and slowness of thought
- Confused episodes.

There may also be:

- Small-stepped, wide-based gait (*marche a petit pas*)
- Pseudobulbar palsy
- Pyramidal signs
- Urinary incontinence
- Cogwheel rigidity
- Impaired eye movement.

One feature that helps to distinguish vascular dementia from AD is that blood pressure is usually raised in the former. However, falls in blood pressure are also associated with vascular dementia.

Once a diagnosis and prognosis has been made, the clinician must co-ordinate the appropriate care services, deliver treatment as necessary and ensure carers are well supported.

The process of determining a prognosis and thus a care plan for an individual patient is made difficult by the number of non-cognitive symptoms seen in dementing disorders.

### **Prognosis and management of the non-cognitive aspects of dementia**

Non-cognitive symptoms are extremely common. Almost all patients experience at one or more of these symptoms during their illness. The difficulty lies in the very limited ability to prognose or predict which symptom is likely to be a problem in which patient. Without treatment, non-cognitive symptoms can increase patient suffering and the burden on carers. They can also lead to premature institutionalization and significant financial costs to the community. Because they are

treatable, it is imperative to recognise the non-cognitive symptoms of dementia and deliver prompt treatment.

Appropriate drug treatment can be efficacious but requires monitoring to avoid the possibility that it might worsen symptoms and induce side-effects (Gelder et al 1996, Lishman 1997, Brody, Lerner and Minneman, 1998).

If symptoms are very troublesome a combination of drugs may be best. As the non-cognitive symptoms of dementia fluctuate throughout the course of the disease it is essential to assess patients regularly to ensure efficacious therapeutic interventions.

#### **Non-cognitive symptoms in dementia and common therapeutic interventions**

- Depression — antidepressants (selective serotonergic reuptake inhibitors, tricyclic anti-depressants).
- Psychosis — antipsychotics
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This ideal is rarely met in practice because of the difficulties involved in generating an accurate clinical prognosis. This failure is due to the complex pathological processes involved in degeneration taking place in the brain and the multi-dimensional nature of the cognitive and non-cognitive symptoms which occur in patients with dementia.

The individual variability in disease progression, symptomatology, response to therapy and adverse events resulting from therapeutic intervention lies at the heart of the difficulties experienced in the clinical management of dementia.

We have elaborated on the value and utility to be derived from the gathering together of the genes which form the core gene list for this particular Genostic system.

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E ENZYME

T TRANSPORT & STORAGE



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Ubiquitin B	UBB	G
Ubiquitin C	UBC	G
Ubiquitin carboxyl-terminal esterase L1	UCHL1	G
UDP-glucuronosyltransferase 1	ugt1d, UGT1	E
UDP-glucuronosyltransferase 2	UGT2	E
Undulin 1	COL14A1	S
Uridinediphosphate(UDP)-galactose-4-epimerase	GALE	E
Uroporphyrinogen III synthase	UROS	E
Vacuolar proton pump, subunit 1	VPP1	N
Vacuolar proton pump, subunit 3	VPP3	N
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I IMMUNITY  
N NERVOUS TRANSMISSION  
G GROWTH & DIFFERENTIATION

**DEMENTIA GENE LIST**

	<b>HUGO gene symbol</b>	<b>Protein function</b>
2,3-bisphosphoglycerate mutase	BPGM	E
3 beta hydroxysteroid dehydrogenase 2	HSD3B2	E
5,10-methylenetetrahydrofolate reductase (NADPH)	MTHFR	E
Acetylcholine receptor, nicotinic, alpha A1	CHRNA1	N
Acetylcholine receptor, nicotinic, alpha A2	CHRNA2	N
Acetylcholine receptor, nicotinic, alpha A3	CHRNA3	N
Acetylcholine receptor, nicotinic, alpha A4	CHRNA4	N
Acetylcholine receptor, nicotinic, alpha A5	CHRNA5	N
Acetylcholine receptor, nicotinic, alpha A6	CHRNA6	N
Acetylcholine receptor, nicotinic, alpha A7	CHRNA7	N
Acetylcholine receptor, nicotinic, beta 1	CHRNA1	N
Acetylcholine receptor, nicotinic, beta 2	CHRNA2	N
Acetylcholine receptor, nicotinic, beta 3	CHRNA3	N
Acetylcholine receptor, nicotinic, beta 4	CHRNA4	N
Acetylcholine receptor, nicotinic, epsilon	CHRNA5	N
Acetylcholine receptor, nicotinic, gamma	CHRNA6	N
Acetylcholinesterase	ACHE	E
Adducin, alpha	ADD1	S
Adducin, beta	ADD2	S
Adenosine receptor A1	ADORA1	N
Adenosine receptor A2A	ADORA2A	N
Adenosine receptor A2B	ADORA2B	N
Adenosine receptor A3	ADORA3	N
Adenylate cyclase 1	ADCY1	E
Adenylate cyclase 2	ADCY2	E
Adenylate cyclase 3	ADCY3	E
Adenylate cyclase 4	ADCY4	E
Adenylate cyclase 5	ADCY5	E
Adenylate cyclase 6	ADCY6	E
Adenylate cyclase 7	ADCY7	E
Adenylate cyclase 8	ADCY8	E
Adenylate cyclase 9	ADCY9	E
Adrenergic receptor, alpha1	ADRA1	N
Adrenergic receptor, alpha2	ADRA2	N
Adrenergic receptor, beta1	ADRB1	N
Adrenergic receptor, beta2	ADRB2	N
Adrenergic receptor, beta3	ADRB3	N
Adrenocorticotrophic hormone (ACTH) receptor	ACTHR	G
Albumin, ALB	ALB	T

Caspase 10	CASP10	G
Caspase 2	CASP2	G
Caspase 3	CASP3	G
Caspase 4	CASP4	G
Caspase 5	CASP5	G
Caspase 6	CASP6	G
Caspase 7	CASP7	G
Caspase 8	CASP8	G
Caspase 9	CASP9	G
Catechol-O-methyltransferase	COMT	E
CD1	CD1	I
CD4	CD4	I
Cell adhesion molecule, intercellular, ICAM	ICAM1	G
Cell adhesion molecule, leukocyte-endothelial, LECAM (CD62)	LECAM1	G
Cell adhesion molecule, liver, LCAM	LCAM	G
Cell adhesion molecule, neural, NCAM1	NCAM1	G
Cell adhesion molecule, neural, NCAM120	NCAM120	G
Cell adhesion molecule, neural, NCAM2	NCAM2	G
Cell adhesion molecule, platelet-endothelial, PECAM	PECAM1	G
Cell adhesion molecule, vascular, VCAM	VCAM1	G
Chemokine receptor CXCR4	CXCR4	I
Choline acetyltransferase	CHAT	E
Chymotrypsinogen		E
Cockayne syndrome gene, CKN1	CKN1	G
Cofilin		S
Collagen I alpha 1	COL1A1	S
Collagen I alpha 2	COL1A2	S
Collagen II alpha 1	COL2A1	S
Collagen III alpha 1	COL3A1	S
Collagen IV alpha 1	COL4A1	S
Collagen IV alpha 2	COL4A2	S
Collagen IV alpha 3	COL4A3	S
Collagen IV alpha 4	COL4A4	S
Collagen IV alpha 5	COL4A5	S
Collagen IV alpha 6	COL4A6	S
Collagen IX alpha 2	COL9A2, EDM2	S
Collagen IX alpha 3	COL9A3	S
Collagen receptor	COLR	S
Collagen V alpha 1	COL5A1	S
Collagen V alpha 2	COL5A2	S
Collagen VI alpha 1	COL6A1	S
Collagen VI alpha 2	COL6A2	S
Collagen VI alpha 3	COL6A3	S
Collagen VII alpha 1	COL7A1	S
Collagen X alpha 1	COL10A1	S
Collagen X alpha 1	COL11A1	S

Collagen XI alpha 2	COL11A2	S
Collagen XVII alpha 1	COL17A1	S
Corticotrophin-releasing hormone	CRH	T
Corticotrophin-releasing hormone receptor	CRHR1	T
Cu <sup>2+</sup> transporting ATPase beta polypeptide	ATP7B	E
Cyclic AMP-dependent protein kinase	PKA	E
Cyclic nucleotide phosphodiesterase 2A3	PDE2A3	E
Cyclic nucleotide phosphodiesterase 3A	PDE3A	E
Cyclic nucleotide phosphodiesterase 3B	PDE3B	E
Cyclic nucleotide phosphodiesterase 4A	PDE4A	E
Cyclic nucleotide phosphodiesterase 4C	PDE4C	E
Cyclic nucleotide phosphodiesterase 5A	PDE5A	E
Cyclic nucleotide phosphodiesterase 6A	PDE6A	E
Cyclic nucleotide phosphodiesterase 6B	PDE6B	E
Cyclic nucleotide phosphodiesterase 7	PDE7	E
Cyclic nucleotide phosphodiesterase 8	PDE8	E
Cyclic nucleotide phosphodiesterase 9A	PDE9A	E
Cyclooxygenase 1	COX1	E
Cyclooxygenase 2	COX2	E
CYP11A1	CYP11A1	E
CYP11B1	CYP11B1	E
CYP11B2	CYP11B2	E
CYP17	CYP17	E
CYP19	CYP19	E
CYP1A1	CYP1A1	E
CYP1A2	CYP1A2	E
CYP1B1	CYP1B1	E
CYP21	CYP21	E
CYP24	CYP24	E
CYP27	CYP27	E
CYP27B1	PDDR	E
CYP2A1	CYP2A1	E
CYP2A13	CYP2A13	E
CYP2A3	CYP2A3	E
CYP2A6V2	CYP2A6V2	E
CYP2A7	CYP2A7	E
CYP2B6	CYP2B6	E
CYP2C18	CYP2C18	E
CYP2C19	CYP2C19	E
CYP2C8	CYP2C8	E
CYP2C9	CYP2C9	E
CYP2D6	CYP2D6	E
CYP2E1	CYP2E1	E
CYP2F1	CYP2F1	E
CYP2J2	CYP2J2	E
CYP3A3	CYP3A3	E
CYP3A4	CYP3A4	E
CYP3A5	CYP3A5	E



CYP3A7	CYP3A7	E
CYP4A11	CYP4A11	E
CYP4B1	CYP4B1	E
CYP4F2	CYP4F2	E
CYP4F3	CYP4F3	E
CYP51	CYP51	E
CYP5A1	CYP5A1	E
CYP7A	CYP7A	E
CYP8	CYP8	E
Cystathione beta synthase	CBS	E
Cystatin C	CST3	T
Cystinosin	CTNS	T
Cytidine-5-prime-triphosphate synthetase	CTPS	E
Cytochrome a		E
Cytochrome b-245 alpha	CYBA	E
Cytochrome b-245 beta	CYBB	E
Cytochrome c		E
Cytochrome c oxidase, MTCO		E
Dihydrolipoyl succinyltransferase	DLST	E
Dopamine beta hydroxylase	DBH	E
Dopamine receptors D1	DRD1	N
Dopamine receptors D2	DRD2	N
Dopamine receptors D3	DRD3	N
Dopamine receptors D4	DRD4	N
Dopamine receptors D5	DRD5	N
Doublecortin, DCX	DCX	S
Emerin	EMD	T
Endothelin 1	EDN1	N
Endothelin 2	EDN2	N
Endothelin 3	EDN3	N
Endothelin converting enzyme	ECE1	N
Endothelin receptor type A	EDNRA	N
Endothelin receptor type B	EDNRB	N
Enolase	ENO1	E
Epidermal growth factor	EGF	G
Epidermal growth factor receptor	EGFR	G
Epilepsy, progressive myoclonic 2 gene	EPM2A	E
Excision repair complementation group 4 protein	ERCC4	E
Factor 1 (No. one)	F1	I
Factor III	F3	I
Factor IX	F9	I
Factor V	F5	I
Factor VII	F7	I
Factor VIII	F8	I
Factor X	F10	I
Factor XI	F11	I
Factor XII	F12	I

Factor XIII A & B	F13A & F13B	I
Fanconi anemia, complementation group A	FANCA	T
Fibrinogen alpha	FGA	S
Fibrinogen beta	FGB	S
Fibrinogen gamma	FGG	S
Fibroblast growth factor	FGF1	G
Fibroblast growth factor receptor 1	FGFR1	G
Fibroblast growth factor receptor 2	FGFR2	G
Fibroblast growth factor receptor 3	FGFR3	G
Fibronectin precursor	FN1	G
Follicle stimulating hormone receptor	FSHR, ODG1	G
Follicle stimulating hormone, FSH	FSHB	G
GABA receptor, alpha 1	GABRA1	N
GABA receptor, alpha 2	GABRA2	N
GABA receptor, alpha 3	GABRA3	N
GABA receptor, alpha 4	GABRA4	N
GABA receptor, alpha 5	GABRA5	N
GABA receptor, alpha 6	GABRA6	N
GABA receptor, beta 1	GABRB1	N
GABA receptor, beta 2	GABRB2	N
GABA receptor, beta 3	GABRB3	N
GABA receptor, gamma 1	GABRG1	N
GABA receptor, gamma 2	GABRG2	N
GABA receptor, gamma 3	GABRG3	N
GABA transaminase	ABAT	E
Galactosyltransferase 1	GT1	G
Galactosyltransferase, alpha 1,3	GGTA1	G
Galactosyltransferase, beta 3	B3GALT	G
Gastric Intrinsic factor, GIF	GIF	E
Glial-cell derived neurotrophic factor (GDNF) receptor		N
Glial-cell derived neurotrophic factor, GDNF	GDNF	N
Glutamate decarboxylase, GAD	GAD1	E
Glutamate receptor 1	GLUR1	N
Glutamate receptor 2	GLUR2	N
Glutamate receptor 3	GLUR3	N
Glutamate receptor 4	GLUR4	N
Glutamate receptor 5	GLUR5	N
Glutamate receptor 6	GLUR6	N
Glutamate receptor 7	GLUR7	N
Glutamate receptor, ionotropic, NMDA 1	NMDAR1	N
Glutamate receptor, ionotropic, NMDA 2A	NMDAR2A	N
Glutamate receptor, ionotropic, NMDA 2B	NMDAR2B	N
Glutamate receptor, ionotropic, NMDA 2C	NMDAR2C	N
Glutamate receptor, ionotropic, NMDA 2D	NMDAR2D	N
Glutaryl-CoA dehydrogenase	GCDH	E
Glutathione	GSH	T
Glutathione S-transferase, GSTZ1	GSTZ1	E

Glyceraldehyde-3-phosphate dehydrogenase, GAPDH	GAPDH	E
Glycerol kinase	GK	E
Glycinamide ribonucleotide (GAR) transformylase	GART	E
Gonadotropin releasing hormone receptor	GNRHR	G
Guanylyl cyclase		E
Haemoglobin alpha 1	HBA1	T
Haemoglobin alpha 2	HBA2	T
Haemoglobin beta	HBB	T
Haemoglobin delta	HBD	T
Haemoglobin gamma A	HBG1	T
Haemoglobin gamma B	HBG2	T
Haemoglobin gamma G	HBGG	T
Heparan sulfamidase		E
Heparin binding epidermal growth factor	HBEGF	G
Heparin Cofactor II	HCF2	I
Hepatic lipase	LIPC	E
Hexosaminidase A	HEXA,TSD	E
Hexosaminidase B	HEXB	E
Hippocampal cholinergic neurostimulating peptide, HCNP		N
Histamine receptors, H1		N
Histamine receptors, H2		N
Histamine receptors, H3		N
Histidase		E
HLA-B associated transcript 1	BAT1	I
HMG-CoA reductase	HMGCR	E
Holocarboxylase synthetase	HLCS	E
Hypoxia inducible factor 1	HIF1A	E
Hypoxia inducible factor 2		E
IC7 A and B		I
Inositol monophosphatase	IMPA1	N
Insulin	INS	G
Insulin receptor	INSR	G
Integrin beta 1	ITGB1	G
Integrin beta 2	ITGB2	G
Integrin beta 3	ITGB3	G
Integrin beta 4	ITGB4	G
Integrin beta 5	ITGB5	G
Integrin beta 6	ITGB6	G
Integrin beta 7	ITGB7	G
Integrin, alpha 1	ITGA1	G
Integrin, alpha 2	ITGA2	G
Integrin, alpha 3	ITGA3	G
Integrin, alpha 4	ITGA4	G
Integrin, alpha 5	ITGA5	G
Integrin, alpha 6	ITGA6	G
Integrin, alpha 7	ITGA7	G

Integrin, alpha 8	ITGA8	G
Integrin, alpha 9	ITGA9	G
Integrin, alpha M	ITGAM	G
Integrin, alpha X	ITGAX	G
Interleukin(IL) 1 receptor	IL1R	I
Interleukin(IL) 1, alpha	IL1A	I
Interleukin(IL) 1, beta	IL1B	I
Interleukin(IL) 10	IL10	I
Interleukin(IL) 10 receptor	IL10R	I
Interleukin(IL) 11	IL11	I
Interleukin(IL) 11 receptor	IL11R	I
Interleukin(IL) 12	IL12	I
Interleukin(IL) 12 receptor, beta 1	IL12RB1	I
Interleukin(IL) 13	IL13	I
Interleukin(IL) 13 receptor	IL13R	I
Interleukin(IL) 2	IL2	I
Interleukin(IL) 2 receptor, alpha	IL2RA	I
Interleukin(IL) 2 receptor, gamma	IL2RG	I
Interleukin(IL) 3	IL3	I
Interleukin(IL) 3 receptor	IL3R	I
Interleukin(IL) 4	IL4	I
Interleukin(IL) 4 receptor	IL4R	I
Interleukin(IL) 5	IL5	I
Interleukin(IL) 5 receptor	IL5R	I
Interleukin(IL) 6	IL6	I
Interleukin(IL) 6 receptor	IL6R	I
Interleukin(IL) 7	IL7	I
Interleukin(IL) 7 receptor	IL7R	I
Interleukin(IL) 8	IL8	I
Interleukin(IL) 8 receptor	IL8R	I
Interleukin(IL) 9	IL9	I
Interleukin(IL) 9 receptor	IL9R	I
Interleukin(IL) receptor antagonist 1	IL1RN, IL1RA	I
IP3 kinase		E
Kallikrein 3	KAK3	I
Kininogen, High molecular weight	KNG	I
Kynureninase		E
Laminin 5, alpha 3	LAMA3	G
Laminin 5, beta 3	LAMB3	G
Laminin 5, gamma 2	LAMC2	G
Laminin M	LAMM	G
Laminin receptor 1	LAMR1	G
Latent transforming growth factor-beta binding protein 2	LTBP2	G
Leptin	LEP	G
Leptin receptor	LEPR	G
Leukin		I
Leukocyte-specific transcript 1	LST-1	I

Leukotriene A4 hydrolase		I
Leukotriene A4 synthase	LTA4S	E
Leukotriene B4 receptor		I
Leukotriene B4 synthase	LTB4S	E
Leukotriene C4 receptor		I
Leukotriene C4 synthase	LTC4S	E
Leukotriene D4/E4 receptor		I
LIM homeobox protein 1	LHX1	G
LIM-Kinase I (LINK-I)		I
Lipoprotein receptor, Low Density	LDLR	T
Lipoprotein, High Density	HDLDT1	T
Lipoprotein, Intermediate Density		T
Lipoprotein, Low Density 1		T
Lipoprotein, Low Density 2		T
Lipoprotein, Very Low Density	VLDLR	T
Low density lipoprotein receptor-related protein precursor	LRP	T
Lymphoid enhancer-binding factor	LEF-1	G
MAD (mothers against decapentaplegic, Drosophila) homologue 4	MADH4	G
Mannosidase, alpha B lysosomal	MANB	E
Mannosidase, beta A lysosomal	MANBA	E
Methionine synthase	MTR	E
Mismatch repair gene, PMSL2	PMS2	G
Molybdenum cofactor synthesis 1	MOCS1	E
Molybdenum cofactor synthesis 2	MOCS2	E
Monoamine oxidase A	MAOA	E
Monoamine oxidase B	MAOB	E
Muscarinic receptor, M1	CHRM1	N
Muscarinic receptor, M2	CHRM2	N
Muscarinic receptor, M3	CHRM3	N
Muscarinic receptor, M4	CHRM4	N
Muscarinic receptor, M5	CHRM5	N
Myelin basic protein		S
N-acetylglucosamine-6-sulfatase	GNS	E
N-acetylglucosaminidase, alpha	NAGLU	E
NADPH-dependent cytochrome P450 reductase	POR	E
NB6		I
Nerve growth factor	NGF	G
Nerve growth factor receptor	NGFR	G
Neurite inhibitory protein		N
Neuroendocrine convertase 1	NEC1, PCSK1	E
Neurofibromin 1	NF1	G
Neurofibromin 2	NF2	G
Neurofilament protein, NF125	NF150	S
Neurofilament protein, NF200	NF200	S
Neurofilament protein, NF68	NF68	S

Neurokinin A	NKNA	N
Neurokinin B	NKNB	N
Neuropeptide Y	NPY	N
Neuropeptide Y receptor Y1	NPY1R	N
Neuropeptide Y receptor Y2	NPY2R	N
Nitric oxide synthase 1, NOS1	NOS1	E
Nitric oxide synthase 2, NOS2	NOS2	E
Nitric oxide synthase 3, NOS3	NOS3	E
Notch 3	NOTCH3	G
Nuclear factor I-kappa-B-like gene	IKBL	I
Nucleoside diphosphate kinase-A	NDPKA	E
Oncogene bcl2		G
Oncogene sis	PDGFB	G
Ornithine delta-aminotransferase	OAT	E
Ornithine transcarbamoylase	OTC, NME1	E
Parkin	PARK2	N
Persyn		S
Phosphoglucose isomerase	GPI	E
Phosphoglycerate kinase 1	PGK1	E
Phospholipase A2, group 10	PLA2G10	I
Phospholipase A2, group 1B	PLA2G1B	I
Phospholipase A2, group 2A	PLA2G2A	I
Phospholipase A2, group 2B	PLA2G2B	I
Phospholipase A2, group 4A	PLA2G4A	I
Phospholipase A2, group 4C	PLA2G4C	I
Phospholipase A2, group 5	PLA2G5	I
Phospholipase A2, group 6	PLA2G6	I
Phospholipase C alpha		I
Phospholipase C beta		I
Phospholipase C delta	PLCD1	I
Phospholipase C epsilon		I
Phospholipase C gamma	PLCG1	I
Plasminogen	PLG	E
Plasminogen activator inhibitor 1	PAI1	E
Plasminogen activator inhibitor 2	PAI2	E
Plasminogen activator receptor, Urokinase	UPAR; PLAUR	S
Plasminogen activator, Tissue	PLAT; TPA	E
Plasminogen activator, Urokinase	UPA; PLAU	E
Platelet derived growth factor	PDGF	G
Platelet derived growth factor receptor	PDGFR	G
Platelet-activating factor receptor	PAFR	I
Postsynaptic density-95 protein	PSD95	N
Potassium inwardly-rectifying channel J1	KCNJ1	N
Potassium voltage-gated channel E1	KCNE1	N
Potassium voltage-gated channel Q1	KCNQ1	N
POU domain, class 1, transcription factor 1 (Pit1)	POU1F1	G
Prekallikrein		I

Presenilin 1	PSEN1	T
Presenilin 2	PSEN2	T
Prion protein	PRNP	N
Procollagen N-protease		E
Proopiomelanocortin	POMC	N
Prostacyclin synthase		I
Prostaglandin 15-OH dehydrogenase	HGPD; PGDH	I
Prostaglandin D - DP receptor		I
Prostaglandin E1 receptor		I
Prostaglandin E2 receptor		I
Prostaglandin E3 receptor		I
Prostaglandin F - FP receptor		I
Prostaglandin I2 receptor		T
Prostaglandin IP receptor		I
Protective protein for beta-galactosidase	PPGB	E
Protein C	PROC	I
Protein C inhibitor	PCI	I
Protein kinase C, alpha	PRKCA	E
Protein kinase C, gamma	PRKCG	E
Protein kinase G		E
Protein phosphatase 1, regulatory (inhibitor) subunit 3	PPP1R3	E
Protein S	PROS1	I
Prothrombin precursor	F2	I
Purine nucleoside phosphorylase	NP	E
Pyruvate carboxylase	PC	E
Renin	REN	E
Replication factor C	RFC2	E
RIGUI	RIGUI	G
S100 calcium-binding protein A1	S100A1	N
S100 calcium-binding protein A2	S100A2	N
S100 calcium-binding protein A3	S100A3	N
S100 calcium-binding protein A4	S100A4	N
S100 calcium-binding protein A5	S100A5	N
S100 calcium-binding protein A6	S100A6	N
S100 calcium-binding protein A7	S100A7	N
S100 calcium-binding protein A8	S100A8	N
S100 calcium-binding protein A9	S100A9	N
S100 calcium-binding protein B	S100B	N
S100 calcium-binding protein P	S100P	N
Secretase, alpha		N
Secretase, beta		N
Secretase, gamma		N
Selectin E	SELE	N
Selectin L	SELL	N
Selectin P	SELP	N
Serotonin N-acetyltransferase	SNAT	E
Serotonin receptor, 5HT1A	HTR1A	N

Serotonin receptor, 5HT1B	HTR1B	N
Serotonin receptor, 5HT1C	HTR1C	N
Serotonin receptor, 5HT1D	HTR1D	N
Serotonin receptor, 5HT1E	HTR1E	N
Serotonin receptor, 5HT1F	HTR1F	N
Serotonin receptor, 5HT2A	HTR2A	N
Serotonin receptor, 5HT2B	HTR2B	N
Serotonin receptor, 5HT2C	HTR2C	N
Serotonin receptor, 5HT3	HTR3	N
Serotonin receptor, 5HT4	HTR4	N
Serotonin receptor, 5HT5	HTR5	N
Serotonin receptor, 5HT6	HTR6	N
Serotonin receptor, 5HT7	HTR7	N
Sodium channel, non-voltage gated 1, alpha	SCNN1A	N
Sodium channel, non-voltage gated 1, beta	SCNN1B	N
Sodium channel, non-voltage gated 1, gamma	SCNN1G	N
Sodium channel, voltage-gated, type 1, beta	SCN1B	N
polypeptide		
Solute carrier family 1 (glutamate transporter), member 1	SLC1A1	T
Solute carrier family 1 (glutamate transporter), member 2	SLC1A2	T
Solute carrier family 12, member 1	SLC12A1	T
Solute carrier family 12, member 2	SLC12A2	T
Solute carrier family 12, member 3	SLC12A3	T
Solute carrier family 18, member 3	SLC18A3	T
Solute carrier family 5 (sodium/glucose transporter), member 1	SLC5A1	T
Solute carrier family 5 (sodium/glucose transporter), member 2	SLC5A2	T
Solute carrier family 5 (sodium/glucose transporter), member 5	SLC5A5	T
Solute carrier family 5, member 3	SLC5A3	T
Solute carrier family 6 (GAMMA-AMINOBUTYRIC ACID transporter), member 1	SLC6A1	T
Solute carrier family 6 (neurotransmitter transporter, dopamine), member 3	SLC6A3	T
Solute carrier family 6 (neurotransmitter transporter, noradrenaline), member 2	SLC6A2	T
Solute carrier family 6 (neurotransmitter transporter, serotonin), member 4	SLC6A4	T
Sphingomyelinase	SMPD1	E
Substance P		N
Succinic semi-aldehyde dehydrogenase	ssadh	E
Sulfite oxidase	SUOX	E
Superoxide dismutase 1	SOD1	E
Superoxide dismutase 3	SOD3	E
Surfeit 1	SURF1	G



Synaptogyrin		N
Synaptophysin	SYP	N
Syntaxin 1	STX1	N
Talin	TLN	G
Tau protein	MAPT	S
TEK, tyrosine kinase, endothelial	TEK	E
Telomerase protein component		E
Thrombin receptor	F2R	I
Thrombopoietin	THPO	G
Thromboxane A synthase 1	TBXAS1	I
Topoisomerase I		E
Transforming growth factor, beta 2	TGFB2	G
Transforming growth factor, beta receptor 2	TGFBR2	G
Tumour necrosis factor (TNF) receptor associated factor 1	TRAF1	I
Tumour necrosis factor (TNF) receptor associated factor 2	TRAF2	I
Tumour necrosis factor (TNF) receptor associated factor 3	TRAF3	I
Tumour necrosis factor (TNF) receptor associated factor 4	TRAF4	I
Tumour necrosis factor (TNF) receptor associated factor 5	TRAF5	I
Tumour necrosis factor (TNF) receptor associated factor 6	TRAF6	I
Tumour necrosis factor alpha	TNFA	I
Tumour necrosis factor alpha receptor	TNFAR	I
Tumour necrosis factor beta	TNFB	I
Tumour necrosis factor beta receptor	TNFBR	I
Tumour protein p53	TP53, P53	G
Tumour protein p63	TP63	G
Tyrosine aminotransferase	TAT	E
Tyrosine hydroxylase	TH	E
Ubiquitin		G
Ubiquitin B	UBB	G
Ubiquitin C	UBC	G
Ubiquitin carboxyl-terminal esterase L1	UCHL1	G
UDP-glucuronosyltransferase 1	ugt1d, UGT1	E
UDP-glucuronosyltransferase 2	UGT2	E
Uridinediphosphate(UDP)-galactose-4-epimerase	GALE	E
Uroporphyrinogen III synthase	UROS	E
Vacuolar proton pump, subunit 1	VPP1	N
Vacuolar proton pump, subunit 3	VPP3	N
Vasoactive intestinal polypeptide	VIP	N
Vasoactive intestinal polypeptide receptor	VIPR	N
Xanthine dehydrogenase	XDH	E

In a seventh aspect.

## PSYCHOSES AND PERSONALITY

The invention relates to a method of assessing the risk of developing clinical or social consequences of psychotic disorders or disorders of personality and indicating appropriate therapeutic interventions.

The 1990's has been heralded as the 'decade of the brain' and the cumulative efforts of research groups around the world have led to considerable advances in our understanding of the principles, physiology and mechanisms of brain, or more properly, central nervous system (CNS) function.

The primary role of CNS function is to gather, integrate, and evaluate information concerning the organisms internal and external environments and then formulate actions designed to achieve the organisms' goals. In man such a simplistic summary lies behind our understanding of the physiology of the simple reflex arc and our crude attempts at investigating the information processing/physiology interface which enables the higher cognitive functions (e.g. reading writing, mathematics, music etc.).

The CNS often referred to as a single organ in the body. In reality it is a closely interconnected series of specialised sub-organs (e.g. hypothalamus, cortex, cerebellum, thalamus etc) which are known to have discrete functions. Understanding brain function implies a clear understanding of the biochemical, physiological and informational parameters which enable the interconnections between these sub-organs and which control the nature, direction and volume of information flow between them.

The CNS is made up of two major types of cells – neurones and glia. Neurones have a variety of morphological types (Betz cell, pyramidal cell etc) but each type has a common set of morphological features – cell body, dendrites, axon and axon terminals. Axons can be very long (up to 1 metre for spinal tracts) and project to distant regions of the CNS. Bundles of axons form the white matter tracts within the CNS. In terms of the processes of communication dendrites and axons are critical features as incoming information is usually received on dendrites whereas axons are the channels for information outflow. Communication between neurones is achieved by means of the release of neurotransmitters (a label which includes many types of molecules e.g. peptides, amines and nitric oxide) from specialised sites on axons - synapses. Thus, the release of neurotransmitters and their movement across the synaptic gap and interaction with receptor sites on neighbouring neurones is the core functional mechanism in the CNS.

Glial cells outnumber neurones and are divided into astrocytes, oligodendrocytes and microglia. Glia had been considered as having a 'support' role for neuronal functioning. It is now realised that their functions' extend far beyond this and that they may be actively involved in the information processing function and in the modulation of the neuronal environment. Microglia have a critical role in the response of the CNS to disease, infection and damage. Such events 'activate' microglia causing

them to release a variety of factors (e.g. cytokines, growth factors) which aid the recovery and regeneration of CNS functions.

The point to point contact between specific sets of neurones is critical for CNS function. Failure of this point to point contact either through dysfunction, damage or disease lies at the heart of the appearance of neurological, psychiatric, psychological or social difficulties following such events (Roberts, Leigh and Weinberger 1993, Youdofsky and Hales 1994, Gelder 1996, Weatherall, Leadingham and Warrell 1996) Lishman 1997).

### PSYCHOSES AND DISORDERS OF PERSONALITY

A number of disorders present as subtle or marked changes from socially accepted norms in the way that ideas, thoughts or mood states are experienced or acted upon. In many cases although the presence of such phenomena can be readily documented at clinical interview, the certain identification of a CNS lesion or biochemical abnormality is not possible.

Examples of psychoses and personality disorders include;

- Schizophrenia
- Depression
- Anxiety states
- Mania
- Delirium
- Paranoia
- Personality disorders
- Sleep disorders
- Psychopathic disorders
- Sociopathic disorders
- Gender disorders
- Substance abuse disorders

Psychoses are disorders of higher cognitive functions characterised by disturbances of reality or perception, impaired cognitive function, psychomotor retardation, thought disorder, affective disorder and depressive or manic symptoms (Gelder et al 1996, Lishman 1997). Schizophrenia is the disease most commonly associated with chronic psychotic states but similar states can be found in individuals with dementia or who have engaged in substance abuse. Delusions, hallucinations, thought disorder and flattening of affect are prominent symptoms in schizophrenia (Gelder et al 1997).

Mood disorders (e.g. depression, anxiety, mania) are also forms of psychotic disorders. As the name suggests the primary symptomatology seen in individuals with these types of psychosis are profound changes in mood (e.g. euphoria, elation, agitation rumination, depression) which is sustained and inappropriate given the individuals circumstances (Roberts, Leigh and Weinberger 1993, Gelder et al 1996, Lishman 1997).

Personality refers to the general way in which a given individual behaves and responds to a wide variety of social and environmental circumstances. The assessment

of personality in relation to illness or injury is of importance as this can determine how a given individual might respond or behave when experiencing the stress of ill health or altered circumstances. Personality disorders are identified when an individual has always behaved in an abnormal fashion (although the definition of such abnormal behaviour is difficult, Gelder et al 1996). In such individuals the difficulties of healthcare management are compounded due to the pre-existing abnormal pattern of behaviour. The types of behavioural traits encountered in personality disorders include paranoia, aloofness, obsession, aggression, dependancy, mistrustfulness, psychopathic, anti-social, passive, impulsive, stubborn, guilt and lack of guilt (Gelder et al 1996).

The range and degree of symptoms present is very variable and the exact boundary between psychotic or personality disorders and 'eccentric' everyday behaviour can be difficult to distinguish. As such there is a considerable interaction between the individuals social environment and the degree or otherwise to which 'abnormal' behaviours or thoughts will be accepted or tolerated.

Some acute psychotic states (often related to substance abuse) resolve fairly rapidly and may leave little or nothing in the way of residual problems. However, the majority of psychotic and personality disorders can give rise to profoundly disabling conditions in which individuals experience significant clinical, psychological, social and economic consequences of their disorders.

Given these difficulties, the management of the healthcare of such patients can include drug treatments, psychotherapy, behavioural modification, psychological counselling, occupational therapies, community care and even psychosurgery.

In many of these disorders drug therapy intended to modify the actions of particular neurotransmitters can be very effective (e.g. neuroleptics, lithium, benzodiazepines). However, many of these drugs also have side-effects such as sedation, orthostatic hypertension, sexual dysfunction, reflex tachycardia and impaired cognition. As a result of the side effects and the disordered mental state of many patients compliance in drug therapy is a significant issue in healthcare management. Such problems can be greatly magnified when dealing with patients with a personality disorder.

The physiology and control of the body's central nervous system is extremely complex and involves the synergistic or inhibitory interaction between multiple regulatory pathways and molecular cascades. Variation in the functionality of the proteins involved in these processes will, inevitably, cause or have an impact on the functioning of these systems or an individuals attempts to minimise damage and restore function following dysfunction, damage or disease in these systems. A number of constitutional factors are known to impact on the individuals ability to deal with and recover from psychotic disorders and disorders of personality including genetic history, age, sex, nutritional status, pre-existing disease or injury, drug treatments and socio-economic circumstances. Genetic variation within individuals is also a key factor although the extent and nature of the genes involved and their precise impact on prognosis, complications, efficacy of therapeutic intervention and eventual recovery of function is largely unknown.

The individual variability in response to the occurrence of psychotic and personality disorders and the associated variation in symptomatology, response to therapy and adverse events resulting from therapeutic interventions lies at the heart of the difficulties experienced in the healthcare and social management of psychotic disorders and disorders of personality.

We have elaborated on the value and utility to be derived from the gathering together of the genes which form the core gene list for this particular Genostic system.

These genes are elaborated below:

#### KEY TO 'PROTEIN FUNCTION' COLUMN

E ENZYME  
T TRANSPORT & STORAGE  
S STRUCTURAL  
I IMMUNITY  
N NERVOUS TRANSMISSION  
G GROWTH & DIFFERENTIATION

PSYCHOSES & PERSONALITY GENE LIST	HUGO gene symbol	Protein function
11beta hydroxysteroid dehydrogenase 2	HSD11B2	E
5,10-methylenetetrahydrofolate reductase (NADPH)	MTHFR	E
Acetylcholine receptor, nicotinic, alpha A1	CHRNA1	N
Acetylcholine receptor, nicotinic, alpha A2	CHRNA2	N
Acetylcholine receptor, nicotinic, alpha A3	CHRNA3	N
Acetylcholine receptor, nicotinic, alpha A4	CHRNA4	N
Acetylcholine receptor, nicotinic, alpha A5	CHRNA5	N
Acetylcholine receptor, nicotinic, alpha A6	CHRNA6	N
Acetylcholine receptor, nicotinic, alpha A7	CHRNA7	N
Acetylcholine receptor, nicotinic, beta 1	CHRNA1	N
Acetylcholine receptor, nicotinic, beta 2	CHRNA2	N
Acetylcholine receptor, nicotinic, beta 3	CHRNA3	N
Acetylcholine receptor, nicotinic, beta 4	CHRNA4	N
Acetylcholine receptor, nicotinic, epsilon	CHRNA5	N
Acetylcholine receptor, nicotinic, gamma	CHRNA6	N
Acetylcholinesterase	ACHE	E
Adenosine receptor A1	ADORA1	N
Adenosine receptor A2A	ADORA2A	N
Adenosine receptor A2B	ADORA2B	N
Adenosine receptor A3	ADORA3	N
Adenylate cyclase 1	ADCY1	E
Adenylate cyclase 2	ADCY2	E
Adenylate cyclase 3	ADCY3	E
Adenylate cyclase 4	ADCY4	E

Adenylate cyclase 5	ADCY5	E
Adenylate cyclase 6	ADCY6	E
Adenylate cyclase 7	ADCY7	E
Adenylate cyclase 8	ADCY8	E
Adenylate cyclase 9	ADCY9	E
Adenylosuccinate lyase	ADSL	E
Adrenergic receptor, alpha1	ADRA1	N
Adrenergic receptor, alpha2	ADRA2	N
Adrenergic receptor, beta1	ADRB1	N
Adrenergic receptor, beta2	ADRB2	N
Adrenergic receptor, beta3	ADRB3	N
Adrenocorticotrophic hormone (ACTH) receptor	ACTHR	G
Albumin, ALB	ALB	T
alpha1-antichymotrypsin	AACT	E
alpha-synuclein	SNCA	N
Amyloid beta A4 precursor protein	APP	N
Amyloid beta A4 precursor-like protein	APLP	N
Apolipoprotein A I	APOA1	T
Apolipoprotein A II	APOA2	T
Apolipoprotein B	APOB	T
Apolipoprotein C1	APOC1	T
Apolipoprotein C2	APOC2	T
Apolipoprotein C3	APOC3	T
Apolipoprotein D	APOD	T
Apolipoprotein E	APOE	T
Apolipoprotein H	APOH	T
Arginosuccinate synthetase	ASS	E
Arylsulfatase A	ARSA	E
Ataxia telangiectasia gene, AT	ATM	G
ATP/ADP translocase		E
Atrial natriuretic peptide	ANP	G
Atrial natriuretic peptide receptor A	NPR1	G
Atrial natriuretic peptide receptor B	NPR2	G
Atrial natriuretic peptide receptor C	NPR3	G
Bagpipe homeobox, drosophila homolog of, 1	BAPX1	G
beta-synuclein	SNCB	N
Brain derived neurotrophic factor	BDNF	G
Brain derived neurotrophic factor (BDNF) receptor	BDNFR	G
C1 inhibitor		E
Ca(2+) transporting ATPase, slow twitch	ATP2A2	T
Calbindin 1	CALB1	G
Calbindin D9K	CALB3	G
Calcineurin A1	CALNA1	I
Calcineurin A2	CALNA2	I
Calcineurin A3	CALNA3	I
Calcineurin B		I

Calcitonin/Calcitonin gene-related peptide alpha	CALCA	N
Calcium channel, voltage-dependent, alpha 1F subunit	CACNA1F	N
Calcium channel, voltage-dependent, Alpha-1B (CACNL1A5)	CACNA1B	N
Calcium channel, voltage-dependent, Alpha-1C	CACNA1C	N
Calcium channel, voltage-dependent, Alpha-1D	CACNA1D	N
Calcium channel, voltage-dependent, Alpha-1E (CACNL1A6)	CACNA1E	N
Calcium channel, voltage-dependent, Alpha-2/delta	CACNA2	N
Calcium channel, voltage-dependent, Beta 1	CACNB1	N
Calcium channel, voltage-dependent, Beta 3	CACNB3	N
Calcium channel, voltage-dependent, Neuronal, Gamma	CACNG2	N
Calcium channel, voltage-dependent, T-type		N
Calmodulin 1	CALM1	G
Calmodulin 2	CALM2	G
Calmodulin 3	CALM3	G
Calmodulin-dependant protein kinase II	CAMK2A	G
Calnexin	CANX	G
Calpain	CAPN, CAPN3	E
Calretinin	CALB2	N
Cannabinoid receptor	CNR1	N
Carbonic anhydrase 3	CA3	E
Carbonic anhydrase 4	CA4	E
Carbonic anhydrase, alpha	CA1	E
Carbonic anhydrase, beta	CA2	E
Cardiac-specific homeobox, CSX	CSX	G
Caspase 1	CASP1	G
Catechol-O-methyltransferase	COMT	E
Ceroid lipofuscinosis neuronal 2	CLN2	N
Ceroid lipofuscinosis neuronal 3	CLN3	N
Ceroid lipofuscinosis neuronal 4	CLN4	N
Ceroid lipofuscinosis neuronal 5	CLN5	N
Ceroid lipofuscinosis neuronal 6	CLN6	N
Chemokine receptor CCR5	CCR5	I
Chemokine receptor CXCR4	CXCR4	I
Cholecystokinin	CCK	N
Cholecystokinin B receptor	CCKBR	N
Choline acetyltransferase	CHAT	E
Chymotrypsinogen		E
Ciliary neurotrophic factor (CNTF)	CNTF	G
Ciliary neurotrophic factor (CNTF) receptor	CNTR	G
Citrate synthase		E

Colony-stimulating factor 2	CSF2	G
Colony-stimulating factor 2 alpha receptor	CSF2RA	G
Corticotrophin-releasing hormone	CRH	T
Corticotrophin-releasing hormone receptor	CRHR1	T
Cu <sup>2+</sup> transporting ATPase beta polypeptide	ATP7B	E
Cyclic AMP response element binding protein	CREB	G
Cyclic AMP-dependent protein kinase	PKA	E
Cyclic nucleotide phosphodiesterase 1B	PDE1B	E
Cyclic nucleotide phosphodiesterase 1B1	PDE1B1	E
Cyclic nucleotide phosphodiesterase 2A3	PDE2A3	E
Cyclic nucleotide phosphodiesterase 3A	PDE3A	E
Cyclic nucleotide phosphodiesterase 3B	PDE3B	E
Cyclic nucleotide phosphodiesterase 4A	PDE4A	E
Cyclic nucleotide phosphodiesterase 4C	PDE4C	E
Cyclic nucleotide phosphodiesterase 5A	PDE5A	E
Cyclic nucleotide phosphodiesterase 6A	PDE6A	E
Cyclic nucleotide phosphodiesterase 6B	PDE6B	E
Cyclic nucleotide phosphodiesterase 7	PDE7	E
Cyclic nucleotide phosphodiesterase 8	PDE8	E
Cyclic nucleotide phosphodiesterase 9A	PDE9A	E
Cyclooxygenase 1	COX1	E
Cyclooxygenase 2	COX2	E
CYP11A1	CYP11A1	E
CYP11B1	CYP11B1	E
CYP11B2	CYP11B2	E
CYP17	CYP17	E
CYP19	CYP19	E
CYP1A1	CYP1A1	E
CYP1A2	CYP1A2	E
CYP1B1	CYP1B1	E
CYP21	CYP21	E
CYP24	CYP24	E
CYP27	CYP27	E
CYP27B1	PDDR	E
CYP2A1	CYP2A1	E
CYP2A13	CYP2A13	E
CYP2A3	CYP2A3	E
CYP2A6V2	CYP2A6V2	E
CYP2A7	CYP2A7	E
CYP2B6	CYP2B6	E
CYP2C18	CYP2C18	E
CYP2C19	CYP2C19	E
CYP2C8	CYP2C8	E
CYP2C9	CYP2C9	E
CYP2D6	CYP2D6	E
CYP2E1	CYP2E1	E
CYP2F1	CYP2F1	E
CYP2J2	CYP2J2	E



CYP3A3	CYP3A3	E
CYP3A4	CYP3A4	E
CYP3A5	CYP3A5	E
CYP3A7	CYP3A7	E
CYP4A11	CYP4A11	E
CYP4B1	CYP4B1	E
CYP4F2	CYP4F2	E
CYP4F3	CYP4F3	E
CYP51	CYP51	E
CYP5A1	CYP5A1	E
CYP7A	CYP7A	E
CYP8	CYP8	E
Cystathionase	CTH	E
Cystathione beta synthase	CBS	E
Cytidine deaminase	CDA	E
Cytidine-5-prime-triphosphate synthetase	CTPS	E
Cytochrome a		E
Cytochrome c		E
Cytochrome c oxidase, MTCO		E
Delta aminolevulinate dehydratase	ALAD	E
Delta-7-dehydrocholesterol reductase	DHCR7	E
Dihydrolipoamide succinyltransferase		N
Dopamine beta hydroxylase	DBH	E
Dopamine receptors D1	DRD1	N
Dopamine receptors D2	DRD2	N
Dopamine receptors D3	DRD3	N
Dopamine receptors D4	DRD4	N
Dopamine receptors D5	DRD5	N
Endothelin 1	EDN1	N
Endothelin 2	EDN2	N
Endothelin 3	EDN3	N
Endothelin converting enzyme	ECE1	N
Endothelin receptor type A	EDNRA	N
Endothelin receptor type B	EDNRB	N
Enolase	ENO1	E
Epidermal growth factor	EGF	G
Epidermal growth factor receptor	EGFR	G
Excision repair complementation group 4 protein	ERCC4	E
Fibroblast growth factor	FGF1	G
Fibroblast growth factor receptor 1	FGFR1	G
Fibroblast growth factor receptor 2	FGFR2	G
Fibroblast growth factor receptor 3	FGFR3	G
Flightless-II, Drosophila homolog of	FLII	G
Fragile site, folic acid type, rare, fra(X) A	FRAXA	N
Fragile site, folic acid type, rare, fra(X) E	FRAXE	N
Fragile site, folic acid type, rare, fra(X) F	FRAXF	N
GABA receptor, alpha 1	GABRA1	N

GABA receptor, alpha 2	GABRA2	N
GABA receptor, alpha 3	GABRA3	N
GABA receptor, alpha 4	GABRA4	N
GABA receptor, alpha 5	GABRA5	N
GABA receptor, alpha 6	GABRA6	N
GABA receptor, beta 1	GABRB1	N
GABA receptor, beta 2	GABRB2	N
GABA receptor, beta 3	GABRB3	N
GABA receptor, gamma 1	GABRG1	N
GABA receptor, gamma 2	GABRG2	N
GABA receptor, gamma 3	GABRG3	N
GABA transaminase	ABAT	E
GDP dissociation inhibitor 1	GDI1	G
Geniospasm 1	GSM1	G
Glial-cell derived neurotrophic factor (GDNF) receptor		N
Glial-cell derived neurotrophic factor, GDNF	GDNF	N
Glutamate decarboxylase, GAD	GAD1	E
Glutamate receptor 1	GLUR1	N
Glutamate receptor 2	GLUR2	N
Glutamate receptor 3	GLUR3	N
Glutamate receptor 4	GLUR4	N
Glutamate receptor 5	GLUR5	N
Glutamate receptor 6	GLUR6	N
Glutamate receptor 7	GLUR7	N
Glutamate receptor, ionotropic, NMDA 1	NMDAR1	N
Glutamate receptor, ionotropic, NMDA 2A	NMDAR2A	N
Glutamate receptor, ionotropic, NMDA 2B	NMDAR2B	N
Glutamate receptor, ionotropic, NMDA 2C	NMDAR2C	N
Glutamate receptor, ionotropic, NMDA 2D	NMDAR2D	N
Glutaryl-CoA dehydrogenase	GCDH	E
Glutathione	GSH	T
Glutathione S-transferase, GSTZ1	GSTZ1	E
Glyceraldehyde-3-phosphate dehydrogenase, GAPDH	GAPDH	E
Glycerol kinase	GK	E
Glycinamide ribonucleotide (GAR) transformylase	GART	E
Gonadotropin releasing hormone receptor	GNRHR	G
Guanidinoacetate N-methyltransferase	GAMT	E
Guanine nucleotide-binding protein, alpha activating activity polypeptide, GNAO	GNAO1	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 1, GNAI1	GNAI1	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 2, GNAI2	GNAI2	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 3, GNAI3	GNAI3	N

Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS1	GNAS1	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS2	GNAS2	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS3	GNAS3	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS4	GNAS4	N
Guanine nucleotide-binding protein, alpha transducing activity polypeptide, GNAT1	GNAT1	N
Guanine nucleotide-binding protein, alpha transducing activity polypeptide, GNAT2	GNAT2	N
Guanine nucleotide-binding protein, beta polypeptide 3	GNB3	N
Guanine nucleotide-binding protein, q polypeptide	GNAQ	N
Guanylate cyclase 2D, membrane (retina-specific)	GUCY2D	E
Guanylate cyclase activator 1A (retina)	GUCA1A	E
Guanylyl cyclase		E
Heat shock protein, HSP60		I
Heat shock protein, HSP70		I
Heat shock protein, HSP90		I
Heat shock protein, HSPA1		I
Heat shock protein, HSPA2		I
Heparan sulfamidase		E
Hepatic lipase	LIPC	E
Histamine receptors, H1		N
Histamine receptors, H2		N
Histamine receptors, H3		N
HMG-CoA reductase	HMGCR	E
Huntingtin	HD	T
Hypoxanthine-guanine phosphoribosyltransferase, HGPRT	HPRT	E
Hypoxia inducible factor 1	HIF1A	E
Hypoxia inducible factor 2		E
Inositol monophosphatase	IMPA1	N
Insulin	INS	G
Insulin receptor	INSR	G
Interleukin(IL) 1 receptor	IL1R	I
Interleukin(IL) 1, alpha	IL1A	I
Interleukin(IL) 1, beta	IL1B	I
Interleukin(IL) 10	IL10	I
Interleukin(IL) 10 receptor	IL10R	I
Interleukin(IL) 11	IL11	I
Interleukin(IL) 11 receptor	IL11R	I
Interleukin(IL) 12	IL12	I
Interleukin(IL) 12 receptor, beta 1	IL12RB1	I

Interleukin(IL) 13	IL13	I
Interleukin(IL) 13 receptor	IL13R	I
Interleukin(IL) 2	IL2	I
Interleukin(IL) 2 receptor, alpha	IL2RA	I
Interleukin(IL) 2 receptor, gamma	IL2RG	I
Interleukin(IL) 3	IL3	I
Interleukin(IL) 3 receptor	IL3R	I
Interleukin(IL) 4	IL4	I
Interleukin(IL) 4 receptor	IL4R	I
Interleukin(IL) 5	IL5	I
Interleukin(IL) 5 receptor	IL5R	I
Interleukin(IL) 6	IL6	I
Interleukin(IL) 6 receptor	IL6R	I
Interleukin(IL) 7	IL7	I
Interleukin(IL) 7 receptor	IL7R	I
Interleukin(IL) 8	IL8	I
Interleukin(IL) 8 receptor	IL8R	I
Interleukin(IL) 9	IL9	I
Interleukin(IL) 9 receptor	IL9R	I
Interleukin(IL) receptor antagonist 1	IL1RN, IL1RA	I
IP3 kinase		E
Leukin		I
Mismatch repair gene, PMSL2	PMS2	G
Monoamine oxidase A	MAOA	E
Monoamine oxidase B	MAOB	E
Muscarinic receptor, M1	CHRM1	N
Muscarinic receptor, M2	CHRM2	N
Muscarinic receptor, M3	CHRM3	N
Muscarinic receptor, M4	CHRM4	N
Muscarinic receptor, M5	CHRM5	N
Myelin basic protein		S
Myosin, light chain 3	MYL3	S
NADPH-dependent cytochrome P450 reductase	POR	E
Nerve growth factor	NGF	G
Nerve growth factor receptor	NGFR	G
Neurite inhibitory protein		N
Neurofibromin 1	NF1	G
Neurofibromin 2	NF2	G
Neurofilament protein, NF125	NF150	S
Neurofilament protein, NF200	NF200	S
Neurofilament protein, NF68	NF68	S
Neurokinin A	NKNA	N
Neurokinin B	NKNB	N
Neuropeptide Y	NPY	N
Neuropeptide Y receptor Y1	NPY1R	N
Neuropeptide Y receptor Y2	NPY2R	N
Neurotensin	NTS	N

Neurotensin receptor	NTSR1	N
Nitric oxide synthase 1, NOS1	NOS1	E
Nitric oxide synthase 2, NOS2	NOS2	E
Nitric oxide synthase 3, NOS3	NOS3	E
Nucleoside diphosphate kinase-A	NDPKA	E
Oncogene sis	PDGFB	G
Opioid receptor, delta	OPRD1	N
Opioid receptor, kappa	OPRK1	N
Opioid receptor, mu	OPRM1	N
Ornithine delta-aminotransferase	OAT	E
Paraoxonase PON1	PON1	E
Parkin	PARK2	N
Phospholipase A2, group 10	PLA2G10	I
Phospholipase A2, group 1B	PLA2G1B	I
Phospholipase A2, group 2A	PLA2G2A	I
Phospholipase A2, group 2B	PLA2G2B	I
Phospholipase A2, group 4A	PLA2G4A	I
Phospholipase A2, group 4C	PLA2G4C	I
Phospholipase A2, group 5	PLA2G5	I
Phospholipase A2, group 6	PLA2G6	I
Phospholipase C alpha		I
Phospholipase C beta		I
Phospholipase C delta	PLCD1	I
Phospholipase C epsilon		I
Phospholipase C gamma	PLCG1	I
Platelet derived growth factor	PDGF	G
Platelet derived growth factor receptor	PDGFR	G
Potassium inwardly-rectifying channel J1	KCNJ1	N
POU domain, class 1, transcription factor 1 (Pit1)	POU1F1	G
Presenilin 1	PSEN1	T
Presenilin 2	PSEN2	T
Prion protein	PRNP	N
Proline dehydrogenase	PRODH	E
Proopiomelanocortin	POMC	N
Prosaposin	PSAP	N
Protective protein for beta-galactosidase	PPGB	E
Protein kinase C, alpha	PRKCA	E
Protein kinase C, gamma	PRKCG	E
Protein kinase G		E
Protein phosphatase 1, regulatory (inhibitor) subunit 3	PPP1R3	E
Proteolipid protein	PLP	N
RIGUI	RIGUI	G
S100 calcium-binding protein A1	S100A1	N
S100 calcium-binding protein A2	S100A2	N
S100 calcium-binding protein A3	S100A3	N
S100 calcium-binding protein A4	S100A4	N

S100 calcium-binding protein A5	S100A5	N
S100 calcium-binding protein A6	S100A6	N
S100 calcium-binding protein A7	S100A7	N
S100 calcium-binding protein A8	S100A8	N
S100 calcium-binding protein A9	S100A9	N
S100 calcium-binding protein B	S100B	N
S100 calcium-binding protein P	S100P	N
Secretase, alpha		N
Secretase, beta		N
Secretase, gamma		N
Serotonin N-acetyltransferase	SNAT	E
Serotonin receptor, 5HT1A	HTR1A	N
Serotonin receptor, 5HT1B	HTR1B	N
Serotonin receptor, 5HT1C	HTR1C	N
Serotonin receptor, 5HT1D	HTR1D	N
Serotonin receptor, 5HT1E	HTR1E	N
Serotonin receptor, 5HT1F	HTR1F	N
Serotonin receptor, 5HT2A	HTR2A	N
Serotonin receptor, 5HT2B	HTR2B	N
Serotonin receptor, 5HT2C	HTR2C	N
Serotonin receptor, 5HT3	HTR3	N
Serotonin receptor, 5HT4	HTR4	N
Serotonin receptor, 5HT5	HTR5	N
Serotonin receptor, 5HT6	HTR6	N
Serotonin receptor, 5HT7	HTR7	N
Sodium channel, non-voltage gated 1, alpha	SCNN1A	N
Sodium channel, non-voltage gated 1, beta	SCNN1B	N
Sodium channel, non-voltage gated 1, gamma	SCNN1G	N
Sodium channel, voltage-gated, type 1, beta polypeptide	SCN1B	N
Solute carrier family 12, member 1	SLC12A1	T
Solute carrier family 12, member 2	SLC12A2	T
Solute carrier family 12, member 3	SLC12A3	T
Solute carrier family 4 (anion exchanger), member 1	SLC4A1	T
Solute carrier family 4 (anion exchanger), member 2	SLC4A2	T
Solute carrier family 4 (anion exchanger), member 3	SLC4A3	T
Solute carrier family 5 (sodium/glucose transporter), member 1	SLC5A1	T
Solute carrier family 5 (sodium/glucose transporter), member 2	SLC5A2	T
Solute carrier family 5 (sodium/glucose transporter), member 5	SLC5A5	T
Solute carrier family 5, member 3	SLC5A3	T
Solute carrier family 6 (GAMMA-AMINOBUTYRIC ACID transporter), member 1	SLC6A1	T

Solute carrier family 6 (neurotransmitter transporter, dopamine), member 3	SLC6A3	T
Solute carrier family 6 (neurotransmitter transporter, noradrenaline), member 2	SLC6A2	T
Solute carrier family 6 (neurotransmitter transporter, serotonin), member 4	SLC6A4	T
Superoxide dismutase 1	SOD1	E
Superoxide dismutase 3	SOD3	E
Synapsin 1a & 1b	SYN1	N
Synapsin 2a & 2b	SYN2	N
Synaptic vesicle amine transporter	SVAT	N
Synaptogyrin		N
Synaptophysin	SYP	N
Synaptosomal-associated protein, 25KD	SNAP25	N
Syntaxin 1	STX1	N
Tachykinin receptor, NK1R	TACR1	N
Tachykinin receptor, NK2R	TACR2	N
Tachykinin receptor, NK3R	TACR3	N
Talin	TLN	G
TEK, tyrosine kinase, endothelial	TEK	E
Telomerase protein component		E
Transcobalamin 1, TCN1		T
Transcobalamin 2, TCN2	TCN2	T
Transcription factor, TUPLE1	TUPLE1	N
Transforming growth factor, beta 2	TGFB2	G
Transforming growth factor, beta induced	TGFB1	G
Transforming growth factor, beta receptor 2	TGFBR2	G
Transthyretin	TTR	T
Trypsin inhibitor		E
Tryptophan 2,3-dioxygenase	TDO2	N
Tryptophan hydroxylase	TPH	E
Tumour necrosis factor (TNF) receptor associated factor 1	TRAF1	I
Tumour necrosis factor (TNF) receptor associated factor 2	TRAF2	I
Tumour necrosis factor (TNF) receptor associated factor 3	TRAF3	I
Tumour necrosis factor (TNF) receptor associated factor 4	TRAF4	I
Tumour necrosis factor (TNF) receptor associated factor 5	TRAF5	I
Tumour necrosis factor (TNF) receptor associated factor 6	TRAF6	I
Tumour necrosis factor alpha	TNFA	I
Tumour necrosis factor alpha receptor	TNFAR	I
Tumour necrosis factor beta	TNFB	I
Tumour necrosis factor beta receptor	TNFBR	I
Tyrosinase	TYR	E

Tyrosine hydroxylase	TH	E
Ubiquitin		G
Ubiquitin activating enzyme, E1		E
Ubiquitin B	UBB	G
Ubiquitin C	UBC	G
Ubiquitin protein ligase E3A	UBE3A	E
UDP-glucuronosyltransferase 1	ugt1d, UGT1	E
UDP-glucuronosyltransferase 2	UGT2	E
Uridinediphosphate(UDP)-galactose-4-epimerase	GALE	E
Vacuolar proton pump, subunit 1	VPP1	N
Vacuolar proton pump, subunit 3	VPP3	N
Vesicular monoamine transporter 1	VMAT1	N
Vesicular monoamine transporter 2	VMAT2	N



In an eighth aspect.

## CARDIOVASCULAR DISORDERS

The invention relates to a method of assessing the risk of developing the symptoms and consequences of damage, disease or dysfunction of the cardiovascular system.

The cardiovascular system serves to deliver oxygen and nutrients to the body tissues and remove wastes. It also serves to transport components of the immune system to the sites of infection and remove the debris of infection.

Disease and dysfunction of the cardiovascular system is the commonest cause of death in the western world. In the USA some 50% of deaths are attributed to symptoms and consequences of cardiovascular disease, dysfunction and damage disease.

The cardiovascular system includes;

- The pumping activity of the heart including the generation of electrical activities to synchronise cardiac muscle contraction and the systems for altering activity in order to maintain an appropriate arterial pressure.
- The vasculature (arteries, arterioles, capillaries and veins) required to transport blood through vascular beds in order to deliver oxygen and nutrients and remove wastes.
- Blood volume and composition, including water and electrolyte balances (in conjunction with the renal system), lipid composition and the proteins required for clotting and lysis.
- The regulation and control of the cardiovascular system is the relationship between it and the central nervous system. Changes in willed intention or responses to environmental events need to be reflected by changes in the ability of the body to alter levels of activity

Disease or dysfunction of the cardiovascular system will give rise to a variety of symptoms requiring careful examination in order to determine the patho-physiological cause and the appropriate treatment required. Common symptoms are:

Breathlessness

Chest pain

Oedema

Fatigue

Syncope and palpitation

Cardiac cachexia

The diverse physiology of the components of the symptoms and consequences of cardiovascular disease, dysfunction and damage system make it vulnerable to damage or disease by a number of pathological processes such as (Weatherall, Leadingham and Warrell 1996);

Arrhythmias

Angina

Ischaemic heart disease

Valve disease

Pericardial disease  
Cardiomyopathy  
Congenital heart disease  
Pulmonary disorders  
Hypertension  
Atheroma  
Cachexia  
Circulatory disorders  
Coagulation/clotting disorders.  
Peripheral arterial disease  
Lymphoedema

As a result of this diversity the treatment of cardiovascular disorders is complex and there is a wide range of therapeutic interventions and options.

Conditions involving disorder of the electrical activity of cardiac muscle (arrhythmias) cause a variety of symptoms ranging from discomfort to sudden death. In many cases clinically significant arrhythmia is associated with heart disease (e.g. myocardial infarction). Arrhythmias can be classified as supraventricular or ventricular arrhythmias and they can be treated by different classes of drug (e.g. digoxin and lignocaine respectively).

Insufficiency of blood to heart muscle can cause the pain associated with angina pectoris. This syndrome is can be treated with drugs which enhance peripheral dilatation such as nitrates, thus reducing venous return. In response to this the ventricular volume is reduced relieving the oxygen deficit and reducing the pain.

High blood pressure is associated with decreased life-expectancy and increased risk of stroke, coronary heart disease and other end organ disease (e.g. retinopathy, peripheral neuropathy, renal failure).

In some patients mild hypertension can be controlled by diet restriction, stopping smoking or reducing alcohol consumption. However, in many cases the problems can be alleviated by appropriate drug treatments such as  $\beta$ -adrenoreceptor antagonists, angiotensin converting enzyme inhibitors and calcium channel antagonists.

Diseases of the cardiovascular system can respond well to drug treatments or, in severe cases, transplantation and significant improvements in the management of patients have been made over the last 3 decades. However, many therapeutic interventions carry the risk of adverse events e.g. the potential for neurological damage following cardiac bypass procedures or the adverse consequences following the interactions between calcium channel antagonists and other drugs.

The physiology and control of the body's cardiovascular system and its response to infection and injury is extremely complex and involves the synergistic or inhibitory interaction between multiple regulatory pathways and molecular cascades. Variation in the functionality of the proteins involved in these processes will, inevitably, have an impact on the functioning and success of the patients attempts to minimise damage

and restore function to the system. A number of constitutional factors are known to impact on the individuals ability to deal with and recover from cardiovascular disease and damage including age, sex, nutritional status, pre-existing disease or injury and drug treatments. Genetic variation within individuals is also a key factor although the extent and nature of the genes involved and their precise impact on prognosis, complications, efficacy of therapeutic intervention and eventual recovery of function is largely unknown.

The individual variability in response to cardiovascular disease, dysfunction and damage and the associated variation in symptomatology, response to therapy and adverse events resulting from therapeutic interventions lies at the heart of the difficulties experienced in the healthcare and social management of injury and infection.

We have elaborated on the value and utility to be derived from the gathering together of the genes which form the core gene list for this particular Genostic system.

These genes are elaborated below:

#### KEY TO 'PROTEIN FUNCTION' COLUMN

E ENZYME  
T TRANSPORT & STORAGE  
S STRUCTURAL  
I IMMUNITY  
N NERVOUS TRANSMISSION  
G GROWTH & DIFFERENTIATION

CARDIOVASCULAR GENE LIST	HUGO gene symbol	Protein function
17beta hydroxysteroid oxidoreductase		E
2,3-bisphosphoglycerate mutase	BPGM	E
3 beta hydroxysteroid dehydrogenase 2	HSD3B2	E
3-oxoacid CoA transferase	OXCT	E
5,10-methylenetetrahydrofolate reductase (NADPH)	MTHFR	E
Acetoacetyl 1-CoA-thiolase	ACAT1	E
Acetoacetyl 2-CoA-thiolase	ACAT2	E
Acetyl CoA acyltransferase	ACAA	E
Acetylcholinesterase	ACHE	E
Acid phosphatase 2, lysosomal	ACP2	E
Acidic amino acid transporter		T
Actin, alpha, cardiac	ACTC	S
Actin, alpha, skeletal	ACTA1	S
Actin, alpha, smooth, aortic	ACTA2	S
Activin A receptor, type 2B	ACVR2B	G
Acyl CoA dehydrogenase, long chain	ACADL	E
Acyl CoA dehydrogenase, very long chain	ACADVL	E

Adaptin, beta 3A	ADTB3A	T
Adducin, alpha	ADD1	S
Adducin, beta	ADD2	S
Adenosine deaminase	ADA	E
Adenosine receptor A1	ADORA1	N
Adenosine receptor A2A	ADORA2A	N
Adenosine receptor A2B	ADORA2B	N
Adenosine receptor A3	ADORA3	N
Adenylate cyclase 1	ADCY1	E
Adenylate cyclase 2	ADCY2	E
Adenylate cyclase 3	ADCY3	E
Adenylate cyclase 4	ADCY4	E
Adenylate cyclase 5	ADCY5	E
Adenylate cyclase 6	ADCY6	E
Adenylate cyclase 7	ADCY7	E
Adenylate cyclase 8	ADCY8	E
Adenylate cyclase 9	ADCY9	E
Adenylate kinase	AK1	E
Adrenergic receptor, alpha1	ADRA1	N
Adrenergic receptor, alpha2	ADRA2	N
Adrenergic receptor, beta1	ADRB1	N
Adrenergic receptor, beta2	ADRB2	N
Adrenergic receptor, beta3	ADRB3	N
Adrenocorticotrophic hormone (ACTH) receptor	ACTHR	G
Alanine aminotransferase		T
Alanine-glyoxylate aminotransferase	AGXT	E
Albumin, ALB	ALB	T
Alcohol dehydrogenase 1	ADH1	E
Alcohol dehydrogenase 2	ADH2	E
Alcohol dehydrogenase 3	ADH3	E
Alcohol dehydrogenase 5	ADH5	E
Alcohol dehydrogenase 6	ADH6	E
Alcohol dehydrogenase 7	ADH7	E
Aldehyde dehydrogenase 1	ALDH1	E
Aldehyde dehydrogenase 10	ALDH10	E
Aldehyde dehydrogenase 2	ALDH2	E
Aldehyde dehydrogenase 5	ALDH5	E
Aldehyde dehydrogenase 6	ALDH6	E
Aldehyde dehydrogenase 7	ALDH7	E
Aldolase A	ALDOA	E
Aldolase B	ALDOB	E
Aldolase C	ALDOC	E
Aldosterone receptor	MLR	G
Alpha 1 acid glycoprotein	AAG; AGP	T
Alpha 2 macroglobulin	A2M	I
alpha1-antitrypsin	PI	E
alpha2-antiplasmin	PLI	E

alpha-actinin 2	ACTN2	G
alpha-actinin 3	ACTN3	G
alpha-Galactosidase A	GLA	E
alpha-L-Iduronidase	IDUA	E
Aminopeptidase P	XPNPEP2	E
Amphiregulin	AREG	G
Amylo-1,6-glucosidase	AGL	E
Angiopoietin 1	ANGPT1	G
Angiopoietin 2	ANGPT2	G
Angiotensin converting enzyme	ACE, DCP1	E
Angiotensin receptor 1	AGTR1	T
Angiotensin receptor 2	AGTR2	T
Angiotensinogen	AGT	E
Ankyrin 1	ANK1	S
Ankyrin 2	ANK2	S
Ankyrin 3	ANK3	S
Annexin 1	ANX 1	I
Antidiuretic hormone receptor	ADHR	T
Antithrombin III	AT3	E
Apolipoprotein (a)	LPA	T
Apolipoprotein A 4	APOA4	T
Apolipoprotein A I	APOA1	T
Apolipoprotein A II	APOA2	T
Apolipoprotein B	APOB	T
Apolipoprotein C1	APOC1	T
Apolipoprotein C2	APOC2	T
Apolipoprotein C3	APOC3	T
Apolipoprotein D	APOD	T
Apolipoprotein E	APOE	T
Apolipoprotein H	APOH	T
Aquaporin 1	AQP1	T
Aquaporin 2	AQP2	T
Arginine vasopressin	AVP	N
Arginine vasopressin receptor 1A	AVPR1A	N
Arginine vasopressin receptor 1B	AVPR1B	N
Arginine vasopressin receptor 2	AVPR2	N
Arginosuccinate lyase	ASL	E
Arylsulfatase B	ARSB	E
Aspartylglucosaminidase	AGA	E
Ataxia telangiectasia gene, AT	ATM	G
ATP/ADP translocase		E
ATP-binding cassette transporter 7	ABC7	I
Atrial natriuretic peptide	ANP	G
Atrial natriuretic peptide receptor A	NPR1	G
Atrial natriuretic peptide receptor B	NPR2	G
Atrial natriuretic peptide receptor C	NPR3	G
Autoimmune regulator, AIRE	AIRE	I
BCL2-related protein A1	BCL2A1	G

beta 2 microglobulin	B2M	I
beta-endorphin receptor		N
Bile acid coenzyme A: amino acid N-acyltransferase	BAAT	E
Bile salt export pump	BSEP, PFIC2	T
Bile salt-stimulated lipase	CEL	E
Bilirubin UDP-glucuronosyltransferase		E
Bloom syndrome protein	BLM	G
Bradykinin receptor B1		I
Bradykinin receptor B2		I
Butyrylcholinesterase	BCHE	E
Ca(2+) transporting ATPase, fast twitch	ATP2A1	T
Ca(2+) transporting ATPase, slow twitch	ATP2A2	T
Cadherin E	CDH1	G
Cadherin EP		G
Cadherin N	CDH2	G
Cadherin P	CDH3	G
Calbindin 1	CALB1	G
Calbindin D9K	CALB3	G
Calcineurin A1	CALNA1	I
Calcineurin A2	CALNA2	I
Calcineurin A3	CALNA3	I
Calcineurin B		I
Calcium channel, voltage-dependent, alpha 1F subunit	CACNA1F	N
Calcium channel, voltage-dependent, Alpha-1B (CACNL1A5)	CACNA1B	N
Calcium channel, voltage-dependent, Alpha-1C	CACNA1C	N
Calcium channel, voltage-dependent, Alpha-1D	CACNA1D	N
Calcium channel, voltage-dependent, Alpha-1E (CACNL1A6)	CACNA1E	N
Calcium channel, voltage-dependent, Alpha-2/delta	CACNA2	N
Calcium channel, voltage-dependent, Beta 1	CACNB1	N
Calcium channel, voltage-dependent, Beta 3	CACNB3	N
Calcium channel, voltage-dependent, L type, alpha 1S subunit	CACNA1S	N
Calcium channel, voltage-dependent, Neuronal, Gamma	CACNG2	N
Calcium channel, voltage-dependent, P/Q type, alpha 1A subunit	CACNA1A	N
Calcium channel, voltage-dependent, T-type		N
Calmodulin 1	CALM1	G
Calmodulin 2	CALM2	G
Calmodulin 3	CALM3	G
Calmodulin-dependant protein kinase II	CAMK2A	G

Calpain	CAPN, CAPN3	E
Calretinin	CALB2	N
Carbonic anhydrase 3	CA3	E
Carbonic anhydrase 4	CA4	E
Carbonic anhydrase, alpha	CA1	E
Carbonic anhydrase, beta	CA2	E
Carboxypeptidase	CPN	E
Cardiac-specific homeobox, CSX	CSX	G
Carnitine acylcarnitine translocase	CACT	E
Carnitine transporter protein	CDSP, SCD	T
Cartilage-hair hypoplasia gene	CHH	N
Catechol-O-methyltransferase	COMT	E
Caveolin 3	CAV3	E
CD1	CD1	I
CD4	CD4	I
Cdc 25 phosphatase		G
Cell adhesion molecule, intercellular, ICAM	ICAM1	G
Cell adhesion molecule, leukocyte- endothelial, LECAM (CD62)	LECAM1	G
Cell adhesion molecule, liver, LCAM	LCAM	G
Cell adhesion molecule, neural, NCAM1	NCAM1	G
Cell adhesion molecule, neural, NCAM120	NCAM120	G
Cell adhesion molecule, neural, NCAM2	NCAM2	G
Cell adhesion molecule, platelet-endothelial, PECAM	PECAM1	G
Cell adhesion molecule, vascular, VCAM	VCAM1	G
Cellubrevin	CEB	N
Ceroid lipofuscinosis neuronal 3	CLN3	N
Ceruloplasmin precursor	CP	E
Chemokine receptor CCR2	CCR2	I
Chemokine receptor CCR3	CCR3	I
Chemokine receptor CCR5	CCR5	I
Chemokine receptor CXCR1	CXCR1	I
Chemokine receptor CXCR2	CXCR2	I
Chemokine receptor CXCR4	CXCR4	I
Chloride channel KB	CLCNKB	S
Cholestasis, progressive familial intrahepatic 1 gene	FIC1	G
Cholesterol ester transfer protein	CETP	T
Choline acetyltransferase	CHAT	E
Chymase	CHY1	
Clathrin		T
Cockayne syndrome gene, CKN1	CKN1	G
Collagen I alpha 1	COL1A1	S
Collagen I alpha 2	COL1A2	S
Collagen II alpha 1	COL2A1	S
Collagen III alpha 1	COL3A1	S
Collagen IV alpha 1	COL4A1	S

Collagen IV alpha 2	COL4A2	S
Collagen IV alpha 3	COL4A3	S
Collagen IV alpha 4	COL4A4	S
Collagen IV alpha 5	COL4A5	S
Collagen IV alpha 6	COL4A6	S
Collagen IX alpha 2	COL9A2, EDM2	S
Collagen IX alpha 3	COL9A3	S
Collagen receptor	COLR	S
Collagen V alpha 1	COL5A1	S
Collagen V alpha 2	COL5A2	S
Collagen VI alpha 1	COL6A1	S
Collagen VI alpha 2	COL6A2	S
Collagen VI alpha 3	COL6A3	S
Collagen VII alpha 1	COL7A1	S
Collagen X alpha 1	COL10A1	S
Collagen X alpha 1	COL11A1	S
Collagen XI alpha 2	COL11A2	S
Collagen XVII alpha 1	COL17A1	S
Collagenic-like tail subunit of asymmetric acetylcholinesterase	COLQ	E
Colony-stimulating factor 2 beta receptor	CSF2RB	G
Colony-stimulating factor 3	CSF3	G
Colony-stimulating factor 3 receptor	CSF3R	G
Corticosteroid binding globulin	CBG	N
Cortico-steroid binding protein		T
Corticotrophin-releasing hormone	CRH	T
Corticotrophin-releasing hormone receptor	CRHR1	T
Creb binding protein	CREBBP	G
Cu <sup>2+</sup> transporting ATPase alpha polypeptide	ATP7A	E
Cu <sup>2+</sup> transporting ATPase beta polypeptide	ATP7B	E
Cubilin	CUBN	T
Cyclic AMP-dependent protein kinase	PKA	E
Cyclin-dependent kinase 2	CDK2	G
Cyclin-dependent kinase inhibitor 1C (P57, KIP2)	CDKN1C	G
Cyclooxygenase 1	COX1	E
Cyclooxygenase 2	COX2	E
CYP11A1	CYP11A1	E
CYP11B1	CYP11B1	E
CYP11B2	CYP11B2	E
CYP17	CYP17	E
CYP19	CYP19	E
CYP1A1	CYP1A1	E
CYP1A2	CYP1A2	E
CYP1B1	CYP1B1	E
CYP21	CYP21	E
CYP24	CYP24	E
CYP27	CYP27	E



CYP27B1	PDDR	E
CYP2A1	CYP2A1	E
CYP2A13	CYP2A13	E
CYP2A3	CYP2A3	E
CYP2A6V2	CYP2A6V2	E
CYP2A7	CYP2A7	E
CYP2B6	CYP2B6	E
CYP2C18	CYP2C18	E
CYP2C19	CYP2C19	E
CYP2C8	CYP2C8	E
CYP2C9	CYP2C9	E
CYP2D6	CYP2D6	E
CYP2E1	CYP2E1	E
CYP2F1	CYP2F1	E
CYP2J2	CYP2J2	E
CYP3A3	CYP3A3	E
CYP3A4	CYP3A4	E
CYP3A5	CYP3A5	E
CYP3A7	CYP3A7	E
CYP4A11	CYP4A11	E
CYP4B1	CYP4B1	E
CYP4F2	CYP4F2	E
CYP4F3	CYP4F3	E
CYP51	CYP51	E
CYP5A1	CYP5A1	E
CYP7A	CYP7A	E
CYP8	CYP8	E
Cystathionase	CTH	E
Cystathione beta synthase	CBS	E
Cytidine deaminase	CDA	E
Cytidine-5-prime-triphosphate synthetase	CTPS	E
Cytochrome a		E
Cytochrome b-5	CYB5	E
Cytochrome c		E
Cytochrome c oxidase, MTCO		E
DAX1 nuclear receptor	DAX1	I
Delta aminolevulinate dehydratase	ALAD	E
Delta(4)-3-oxosteroid 5-beta-reductase		E
Delta-7-dehydrocholesterol reductase	DHCR7	E
Deoxycorticosterone (DOC) receptor		E
Desmin	DES	S
Dihydrodiol dehydrogenase 1	DDH1	E
Dihydrofolate reductase	DHFR	E
Dihydrolipoyl dehydrogenase		E
Dihydrolipoyl dehydrogenase 2	PDHA	E
Dihydrolipoyl transacetylase	PDHA	E
DM-Kinase	DMPK	E
DOPA decarboxylase	DDC	E

Dopamine beta hydroxylase	DBH	E
Dopamine receptors D1	DRD1	N
Dopamine receptors D2	DRD2	N
Dopamine receptors D3	DRD3	N
Dopamine receptors D4	DRD4	N
Dopamine receptors D5	DRD5	N
Duffy blood group	FY	T
Dynamin	DNM1	G
Dystrophia myotonica	DM, DMPK	E
Dystrophia myotonica, atypical	DM2	E
Dystrophin	DMD	S
Elastin	ELN	S
Emerin	EMD	T
Endocardial fibroelastosis 2 gene	EFE2	S
Endoglin	ENG	S
Endometrial bleeding-associated factor	EBAF	G
Endothelin 1	EDN1	N
Endothelin 2	EDN2	N
Endothelin 3	EDN3	N
Endothelin converting enzyme	ECE1	N
Endothelin receptor type A	EDNRA	N
Endothelin receptor type B	EDNRB	N
Enolase	ENO1	E
Enoyl CoA isomerase		E
Ephrin receptor tyrosine kinase A	EPHA	G
Ephrin receptor tyrosine kinase B	EPHB	G
Epidermal growth factor	EGF	G
Epidermal growth factor receptor	EGFR	G
Erythrocyte membrane protein band 4.1	EPB41	S
Erythrocyte membrane protein band 4.2	EPB42	S
Erythrocyte membrane protein band 7.2	EPB72	S
Erythroid kruppel-like factor	EKLF	G
Erythropoietin	EPO	I
Erythropoietin receptor	EPOR	I
Estrogen receptor	ESR	G
Faciogenital dysplasia	FGD1, FGDY	T
Factor 1 (No. one)	F1	I
Factor B, properdin		I
Factor D		I
Factor H	HF1	I
Factor I (letter I)	IF	I
Factor III	F3	I
Factor IX	F9	I
Factor V	F5	I
Factor VII	F7	I
Factor VIII	F8	I
Factor X	F10	I
Factor XI	F11	I

Factor XII	F12	I
Factor XIII A & B	F13A & F13B	I
Fanconi anemia, complementation group A	FANCA	T
Fanconi anemia, complementation group C	FANCC	T
Fanconi anemia, complementation group D	FANCD	T
Fatty acid binding proteins FABP1		T
Fatty acid binding proteins FABP2	FABP2	T
Fatty acid binding proteins FABP3		T
Fatty acid binding proteins FABP4		T
Fatty acid binding proteins FABP5		T
Fatty acid binding proteins FABP6		T
Fc fragment of IgG, high affinity IA, receptor for	FCGR1A	G
Fc fragment of IgG, low affinity IIa, receptor for (CD32)	FCGR2A	G
Fc fragment of IgG, low affinity IIIa, receptor for (CD16)	FCGR3A	G
Fibrillin 1	FBN1	G
Fibrillin 2	FBN2	G
Fibrinogen alpha	FGA	S
Fibrinogen beta	FGB	S
Fibrinogen gamma	FGG	S
Fibroblast growth factor	FGF1	G
Fibroblast growth factor receptor 1	FGFR1	G
Fibroblast growth factor receptor 2	FGFR2	G
Fibroblast growth factor receptor 3	FGFR3	G
Fibronectin precursor	FN1	G
Flightless-II, Drosophila homolog of	FLII	G
Follicle stimulating hormone receptor	FSHR, ODG1	G
Follicle stimulating hormone, FSH	FSHB	G
Formiminotransferase		E
Fragile site, folic acid type, rare, fra(X) A	FRAXA	N
Fucosidase alpha-L-2		E
Fucosyltransferase 2	FUT2	T
Fucosyltransferase 3	FUT3	T
Fucosyltransferase 6	FUT6	T
Fukuyama type congenital muscular dystrophy	FCMD	G
GABA receptor, alpha 1	GABRA1	N
GABA receptor, alpha 2	GABRA2	N
GABA receptor, alpha 3	GABRA3	N
GABA receptor, alpha 4	GABRA4	N
GABA receptor, alpha 5	GABRA5	N
GABA receptor, alpha 6	GABRA6	N
GABA receptor, beta 1	GABRB1	N
GABA receptor, beta 2	GABRB2	N
GABA receptor, beta 3	GABRB3	N
GABA receptor, gamma 1	GABRG1	N

GABA receptor, gamma 2	GABRG2	N
GABA receptor, gamma 3	GABRG3	N
GABA transaminase	ABAT	E
Galactose 1-phosphate uridyl-transferase	GALT	E
Galactosyltransferase 1	GT1	G
Galactosyltransferase, alpha 1,3	GGTA1	G
Galactosyltransferase, beta 3	B3GALT	G
Galanin	GAL	N
Galanin receptor	GALNR1	N
Gamma-glutamyl carboxylase	GGCX	T
Gap junction protein alpha 1	GJA1	T
Gap junction protein beta 1	GJB1	T
Gap junction protein beta 2	GJB2	T
Glucocorticoid receptor	GRL	G
Glucosaminyl (N-acetyl) transferase 2, l- branching enzyme	GCNT2	E
Glucosidase, acid alpha	GAA	E
Glucosidase, acid beta	GBA	E
Glutamate decarboxylase, GAD	GAD1	E
Glutamate receptor 1	GLUR1	N
Glutamate receptor 2	GLUR2	N
Glutamate receptor 3	GLUR3	N
Glutamate receptor 4	GLUR4	N
Glutamate receptor 5	GLUR5	N
Glutamate receptor 6	GLUR6	N
Glutamate receptor 7	GLUR7	N
Glutamate receptor, ionotropic, NMDA 1	NMDAR1	N
Glutamate receptor, ionotropic, NMDA 2A	NMDAR2A	N
Glutamate receptor, ionotropic, NMDA 2B	NMDAR2B	N
Glutamate receptor, ionotropic, NMDA 2C	NMDAR2C	N
Glutamate receptor, ionotropic, NMDA 2D	NMDAR2D	N
Glutamate-cysteine ligase	GLCLC	E
Glutaryl-CoA dehydrogenase	GCDH	E
Glutathione	GSH	T
Glutathione peroxidase, GPX1	GPX1	E
Glutathione reductase, GSR	GSR	E
Glutathione S-transferase, GSTZ1	GSTZ1	E
Glyceraldehyde-3-phosphate dehydrogenase, GAPDH	GAPDH	E
Glycerol kinase	GK	E
Glycinamide ribonucleotide (GAR) transformylase	GART	E
Glycophorin A	GYPA	S
Glycophorin B	GYPB	S
Glycophorin C	GYPC	S
Glycosyltransferases, ABO blood group	ABO	E
Growth arrest-specific homeobox	GAX	G
Guanine nucleotide-binding protein, alpha	GNAO1	N

activating activity polypeptide, GNAO		
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 1, GNAI1	GNAI1	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 2, GNAI2	GNAI2	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 3, GNAI3	GNAI3	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS1	GNAS1	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS2	GNAS2	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS3	GNAS3	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS4	GNAS4	N
Guanine nucleotide-binding protein, beta polypeptide 3	GNB3	N
Guanine nucleotide-binding protein, gamma polypeptide 5	GNG5	N
Guanine nucleotide-binding protein, q polypeptide	GNAQ	N
Guanylyl cyclase		E
H(+), K(+) - ATPase	ATP4B	N
Haemoglobin alpha 1	HBA1	T
Haemoglobin alpha 2	HBA2	T
Haemoglobin beta	HBB	T
Haemoglobin delta	HBD	T
Haemoglobin epsilon		T
Haemoglobin gamma A	HBG1	T
Haemoglobin gamma B	HBG2	T
Haemoglobin gamma G	HBGG	T
Haptoglobin, alpha 1	HPA1	I
Haptoglobin, alpha 2	HPA2	I
Haptoglobin, beta	HPB	I
Heat shock protein, HSP60		I
Heat shock protein, HSP70		I
Heat shock protein, HSP90		I
Heat shock protein, HSPA1		I
Heat shock protein, HSPA2		I
Hemochromatosis	HFE	T
Hemopexin	HPX	I
Heparan sulfamidase		E
Heparin binding epidermal growth factor	HBEGF	G
Heparin Cofactor II	HCF2	I
Hepatic lipase	LIPC	E
Hermansky-pudlak syndrome gene	HPS	T
Hexokinase 1	HK1	E
Hexosaminidase A	HEXA,TSD	E

Hexosaminidase B	HEXB	E
Histidine-rich glycoprotein	HRG	T
HLA-B associated transcript 1	BAT1	I
HLH transcription factor HAND1	HAND1	G
HLH transcription factor HAND2	HAND2	G
HMG-CoA lyase	HMGCL	E
HMG-CoA reductase	HMGCR	E
HMG-CoA synthase	HMGCS2	E
Homeobox (HOX) gene A13	HOXA13	G
Homeobox HB24	HLX1	G
Hormone-sensitive lipase	HSL	E
Human chorionic gonadotrophin, hCG	CG	G
Human placental lactogen	CSH1	G
Hypoxanthine-guanine phosphoribosyltransferase, HGPRT	HPRT	E
Hypoxia inducible factor 1	HIF1A	E
Hypoxia inducible factor 2		E
IC7 A and B		I
Iduronate 2 sulphatase	IDS	E
Indian hedgehog, ihh	IHH	G
Inosine triphosphatase	ITPA	E
Inositol 1,4,5-triphosphate receptor 1	ITPR1	G
Inositol 1,4,5-triphosphate receptor 3	ITPR3	G
Inositol monophosphatase	IMPA1	N
Inositol polyphosphate 1-phosphatase	INPP1	N
Insulin	INS	G
Insulin receptor	INSR	G
Insulin receptor substrate-1	IRS1	G
Insulin-like growth factor 1	IGF1	G
Insulin-like growth factor 1 receptor	IGF1R	G
Insulin-like growth factor 2	IGF2	G
Insulin-like growth factor 2 receptor	IGF2R	G
Integrin beta 1	ITGB1	G
Integrin beta 2	ITGB2	G
Integrin beta 3	ITGB3	G
Integrin beta 4	ITGB4	G
Integrin beta 5	ITGB5	G
Integrin beta 6	ITGB6	G
Integrin beta 7	ITGB7	G
Integrin, alpha 1	ITGA1	G
Integrin, alpha 2	ITGA2	G
Integrin, alpha 3	ITGA3	G
Integrin, alpha 4	ITGA4	G
Integrin, alpha 5	ITGA5	G
Integrin, alpha 6	ITGA6	G
Integrin, alpha 7	ITGA7	G
Integrin, alpha 8	ITGA8	G
Integrin, alpha 9	ITGA9	G

Integrin, alpha M	ITGAM	G
Integrin, alpha X	ITGAX	G
Inter-alpha-trypsin inhibitor, IATI		E
Intercellular adhesion molecule 1	ICAM1	I
Intercellular adhesion molecule 2	ICAM2	I
Intercellular adhesion molecule 3	ICAM3	I
Interferon alpha	IFNA1	I
Interferon beta	IFNB	I
Interferon gamma	IFNG	I
Interferon gamma receptor 1	IFNGR1	I
Interferon gamma receptor 2	IFNGR2	I
Interleukin(IL) 1 receptor	IL1R	I
Interleukin(IL) 1, alpha	IL1A	I
Interleukin(IL) 1, beta	IL1B	I
Interleukin(IL) 10	IL10	I
Interleukin(IL) 10 receptor	IL10R	I
Interleukin(IL) 11	IL11	I
Interleukin(IL) 11 receptor	IL11R	I
Interleukin(IL) 12	IL12	I
Interleukin(IL) 12 receptor, beta 1	IL12RB1	I
Interleukin(IL) 13	IL13	I
Interleukin(IL) 13 receptor	IL13R	I
Interleukin(IL) 2	IL2	I
Interleukin(IL) 2 receptor, alpha	IL2RA	I
Interleukin(IL) 2 receptor, gamma	IL2RG	I
Interleukin(IL) 3	IL3	I
Interleukin(IL) 3 receptor	IL3R	I
Interleukin(IL) 4	IL4	I
Interleukin(IL) 4 receptor	IL4R	I
Interleukin(IL) 5	IL5	I
Interleukin(IL) 5 receptor	IL5R	I
Interleukin(IL) 6	IL6	I
Interleukin(IL) 6 receptor	IL6R	I
Interleukin(IL) 7	IL7	I
Interleukin(IL) 7 receptor	IL7R	I
Interleukin(IL) 8	IL8	I
Interleukin(IL) 8 receptor	IL8R	I
Interleukin(IL) 9	IL9	I
Interleukin(IL) 9 receptor	IL9R	I
Interleukin(IL) receptor antagonist 1	IL1RN, IL1RA	I
IP3 kinase		E
Isovaleric acid CoA dehydrogenase	IVD	E
Kallikrein 3	KAK3	I
Kell blood group precursor	XK, KEL	T
Ketohexokinase	KHK	E
Kininogen, High molecular weight	KNG	I
Kynureninease		E
Lactate dehydrogenase, A	LDHA	E

Lactate dehydrogenase, B	LDHB	E
Lamin A/C	LMNA	G
Laminin 5, alpha 3	LAMA3	G
Laminin 5, beta 3	LAMB3	G
Laminin 5, gamma 2	LAMC2	G
Laminin M	LAMM	G
Laminin receptor 1	LAMR1	G
Latent transforming growth factor-beta binding protein 2	LTBP2	G
Lecithin-cholesterol acyltransferase	LCAT	E
Lectin, mannose-binding 1	LMAN1	I
Lectin, mannose-binding 2	MBL2	I
Leptin	LEP	G
Leptin receptor	LEPR	G
Leukocyte-specific transcript 1	LST-1	I
Leukotriene A4 synthase	LTA4S	E
Leukotriene B4 receptor		I
Leukotriene B4 synthase	LTB4S	E
Leukotriene C4 synthase	LTC4S	E
LIM homeobox protein 1	LHX1	G
Lipocortin 1	ANX4	I
Lipoprotein lipase	LPL	I
Lipoprotein receptor, Low Density	LDLR	T
Lipoprotein, High Density	HDLDT1	T
Lipoprotein, Very Low Density	VLDLR	T
Lipoprotein-associated coagulation factor	LACI	I
Lipoxygenase		E
Lipoxygenase 12 (platelets)	LOG12	I
Long QT-type 2 potassium channels	LQT2, KCNH2	T
Low density lipoprotein receptor-related protein precursor	LRP	T
Lymphoid enhancer-binding factor	LEF-1	G
Lysosomal acid lipase	LIPA	E
Macrophage inflammatory protein-2	MIP2	I
MAD (mothers against decapentaplegic, Drosophila) homologue 4	MADH4	G
MADS box transcription-enhancer factor 2A	MEF2A	G
MADS box transcription-enhancer factor 2B	MEF2B	G
Mannosidase, alpha B lysosomal	MANB	E
Matrix Gla protein	MGP	G
Matrix metalloproteinase 1	MMP1	E
Matrix metalloproteinase 10	MMP10	E
Matrix metalloproteinase 11	MMP11	E
Matrix metalloproteinase 12	MMP12	E
Matrix metalloproteinase 13	MMP13	E
Matrix metalloproteinase 14	MMP14	E
Matrix metalloproteinase 15	MMP15	E
Matrix metalloproteinase 16	MMP16	E



Matrix metalloproteinase 17	MMP17	E
Matrix metalloproteinase 18	MMP18	E
Matrix metalloproteinase 19	MMP19	E
Matrix metalloproteinase 2	MMP2	E
Matrix metalloproteinase 3	MMP3, STMY1	E
Matrix metalloproteinase 4	MMP4	E
Matrix metalloproteinase 5	MMP5	E
Matrix metalloproteinase 6	MMP6	E
Matrix metalloproteinase 7	MMP7	E
Matrix metalloproteinase 8	MMP8	E
Matrix metalloproteinase 9	MMP9	E
Melanocortin 2 receptor	MC2R	T
Melanocortin 4 receptor	MC4R	T
Methionine synthase	MTR	E
Methionine synthase reductase	MTRR	E
Methylmalonyl-CoA mutase	MUT	E
Mevalonate kinase	MVK	E
MHC Class I: A		I
MHC Class I: B		I
MHC Class I: C		I
MHC Class I: LMP-2, LMP-7		I
MHC Class I: Tap1	ABCR, TAP1	I
MHC Class II: DP	HLA-DPB1	I
MHC Class II: DQ		I
MHC Class II: DR		I
MHC Class II: Tap2	TAP2, PSF2	I
MHC Class II:Complementation group A	MHC2TA	I
MHC Class II:Complementation group B	rfxank	I
MHC Class II:Complementation group C	RFX5	I
MHC Class II:Complementation group D	RFXAP	I
Microsomal triglyceride transfer protein	MTP	T
Mismatch repair gene, PMSL2	PMS2	G
Mitochondrial trifunctional protein, alpha subunit	HADHA	E
Mitochondrial trifunctional protein, beta subunit	HADHB	E
Molybdenum cofactor synthesis 1	MOCS1	E
Molybdenum cofactor synthesis 2	MOCS2	E
Monoamine oxidase A	MAOA	E
Monoamine oxidase B	MAOB	E
Monocyte chemoattractant protein 1	MCP1	I
Mucopolidoses	GNPTA	E
Mulibrey nanism	MUL	T
Muscarinic receptor, M1	CHRM1	N
Muscarinic receptor, M2	CHRM2	N
Muscarinic receptor, M3	CHRM3	N
Muscarinic receptor, M4	CHRM4	N
Muscarinic receptor, M5	CHRM5	N

MutS homolog 3	MSH3	G
Myoglobin		T
Myosin, cardiac	MYH7	S
Myosin, light chain 2	MYL2	S
Myosin, light chain 3	MYL3	S
Myosin-binding protein C, cardiac	MYBPC3	S
Myotubularin	MTM1	S
Na <sup>+</sup> , K <sup>+</sup> ATPase, alpha	ATP1A1	G
Na <sup>+</sup> , K <sup>+</sup> ATPase, beta 1	ATP1B1	G
Na <sup>+</sup> , K <sup>+</sup> ATPase, beta 2	ATP1B2	G
Na <sup>+</sup> , K <sup>+</sup> ATPase, beta 3	ATP1B3	G
Na <sup>+</sup> /H <sup>+</sup> exchanger 1	NHE1	T
Na <sup>+</sup> /H <sup>+</sup> exchanger 2	NHE2	T
Na <sup>+</sup> /H <sup>+</sup> exchanger 3	NHE3	T
Na <sup>+</sup> /H <sup>+</sup> exchanger 4	NHE4	T
Na <sup>+</sup> /H <sup>+</sup> exchanger 5	NHE5	T
N-acetylglucosamine-6-sulfatase	GNS	E
NADPH oxidase		I
NADPH-dependent cytochrome P450 reductase	POR	E
NB6		I
Nebulin	NEB	S
Nephronophthisis 1	NPHP1	T
Neuraminidase sialidase	NEU	T
Neuregulin	HGL	G
Neurite inhibitory protein		N
Neuroendocrine convertase 1	NEC1, PCSK1	E
Neurokinin A	NKNA	N
Neurokinin B	NKNB	N
Neuropeptide Y	NPY	N
Neuropeptide Y receptor Y1	NPY1R	N
Neuropeptide Y receptor Y2	NPY2R	N
Neutrophil cystolic factor 1	NCF1	I
Neutrophil cystolic factor 2	NCF2	I
Niemann-Pick disease protein	NPC1	T
Nitric oxide synthase 1, NOS1	NOS1	E
Nitric oxide synthase 2, NOS2	NOS2	E
Nitric oxide synthase 3, NOS3	NOS3	E
Notch ligand - jagged 1	JAG1, AGS	G
Nuclear factor I-kappa-B-like gene	IKBL	I
Oncogene sis	PDGFB	G
Oncostatin M	OSM	G
Oncostatin M receptor	OSMR	G
Osteonectin	ON	G
Osteopontin	OPN	G
Osteoprotegerin	OPG	G
Pancreatic lipase	PNLIP	E
Pancreatic lipase related protein 1	PLRP1	E

Pancreatic lipase related protein 2	PLRP2	E
Paraoxonase PON1	PON1	E
Paraoxonase PON2	PON2	E
Paraoxonase PON3		E
Parvalbumin	PVALB	G
Patched (Drosophila) homolog, PTCH	PTCH	G
PCNA (proliferating cell nuclear antigen)		E
Pepsinogen		E
Peroxidase, salivary	SAPX	E
Peroxisomal membrane protein 1	PXMP1	S
Peroxisomal membrane protein 3	PXMP3	T
Peroxisome biogenesis factor 1	PEX1	T
Peroxisome biogenesis factor 19	PEX19	T
Peroxisome biogenesis factor 6	PEX6	T
Peroxisome biogenesis factor 7	PEX7	T
Peroxisome proliferative activated receptor, alpha	PPARA	T
Peroxisome proliferative activated receptor, gamma	PPARG	T
Peroxisome receptor 1	PXR1	T
P-glycoprotein 3	PGY3	T
Phosphatidylinositol glycan, class A (paroxysmal nocturnal hemoglobinuria)	PIGA	G
Phosphatidylinositol transfer protein	PITPN	G
Phosphofructokinase, muscle	PFKM	E
Phosphoglucose isomerase	GPI	E
Phospholipase A2, group 10	PLA2G10	I
Phospholipase A2, group 1B	PLA2G1B	I
Phospholipase A2, group 2A	PLA2G2A	I
Phospholipase A2, group 2B	PLA2G2B	I
Phospholipase A2, group 4A	PLA2G4A	I
Phospholipase A2, group 4C	PLA2G4C	I
Phospholipase A2, group 5	PLA2G5	I
Phospholipase A2, group 6	PLA2G6	I
Phospholipase C alpha		I
Phospholipase C beta		I
Phospholipase C delta	PLCD1	I
Phospholipase C epsilon		I
Phospholipase C gamma	PLCG1	I
Phosphomannomutase-2	PMM2	T
Phosphoribosyl pyrophosphate synthetase	PRPS1	E
Phosphorylase kinase, alpha 2	PHKA2	E
Phytanoyl-CoA hydroxylase	PHYH	G
Plasminogen	PLG	E
Plasminogen activator inhibitor 1	PAI1	E
Plasminogen activator inhibitor 2	PAI2	E
Plasminogen activator receptor, Urokinase	UPAR; PLAUR	S
Plasminogen activator, Tissue	PLAT; TPA	E

Plasminogen activator, Urokinase	UPA; PLAU	E
Platelet derived growth factor	PDGF	G
Platelet derived growth factor receptor	PDGFR	G
Platelet glutaminase	GLS	T
Platelet glycoprotein 1b, alpha	GP1BA	I
Platelet glycoprotein 1b, beta	GP1BB	I
Platelet glycoprotein 1b, gamma	GP1BG	I
Platelet glycoprotein IX	GP9	I
Platelet glycoprotein V	GP5	I
Platelet monamine oxidase		T
Platelet-activating factor acetylhydrolase 1B	PAFAH1B1 or LIS1	I
Platelet-activating factor acetylhydrolase 2	PAFAH2	I
Platelet-activating factor receptor	PAFR	I
Poly (ADP-ribose) synthetase	PARS	E
Polycystic kidney and hepatic disease 1	PKHD1	T
Polycystin 1	PKD1	T
Polycystin 2	PKD2	T
Potassium inwardly-rectifying channel J1	KCNJ1	N
Potassium inwardly-rectifying channel J11	KCNJ11	N
Potassium voltage-gated channel A1	KCNA1	N
Potassium voltage-gated channel E1	KCNE1	N
Potassium voltage-gated channel Q1	KCNQ1	N
Potassium voltage-gated channel Q2	KCNQ2	N
Potassium voltage-gated channel Q3	KCNQ3	N
POU domain, class 1, transcription factor 1 (Pit1)	POU1F1	G
Prekallikrein		I
Procollagen N-protease		E
Progesterone receptor (RU486 binding receptor)	PGR	G
Pro-melanin-concentrating hormone	PMCH	G
Proopiomelanocortin	POMC	N
Prostaglandin (PG) D synthase, hematopoietic	PGDS	E
Prostaglandin E2 receptor		I
Prostaglandin-endoperoxidase synthase 2	PTGS2	G
Protease inhibitor 1		T
Protease nexin 2	PN2	E
Protective protein for beta-galactosidase	PPGB	E
Protein C	PROC	I
Protein C inhibitor	PCI	I
Protein S	PROS1	I
Prothrombin precursor	F2	I
Protoporphyrinogen oxidase	PPOX	E
Purine nucleoside phosphorylase	NP	E
Purinergic receptor P1A1		N
Purinergic receptor P1A2		N

Purinergic receptor P1A3		N
Purinergic receptor P2X, 1	P2RX1	N
Purinergic receptor P2X, 2	P2RX2	N
Purinergic receptor P2X, 3	P2RX3	N
Purinergic receptor P2X, 4	P2RX4	N
Purinergic receptor P2X, 5	P2RX5	N
Purinergic receptor P2X, 6	P2RX6	N
Purinergic receptor P2X, 7	P2RX7	N
Purinergic receptor P2Y, 1	P2RY1	N
Purinergic receptor P2Y, 11	P2RY11	N
Purinergic receptor P2Y, 2	P2RY2	N
Pyruvate carboxylase	PC	E
Pyruvate decarboxylase	PDH4A	E
Pyruvate kinase	PKLR	E
Radixin	RDX	S
Renin	REN	E
Replication factor C	RFC2	E
Retinoic acid receptor, alpha	RARA	G
Retinoic acid receptor, beta	RARB	G
Retinoic acid receptor, gamma	RARG	G
Retinoid X receptor, alpha	RXRA	G
Retinoid X receptor, beta	RXRB	G
Retinoid X receptor, gamma	RXRG	G
Rhesus blood group, CcEe antigens	RHCE	T
Rhesus blood group, D antigen	RHD	T <sup>o</sup>
Rhesus blood group-associated glycoprotein	RHAG	T
Ribosomal protein S19	RPS19	E
RIGUI	RIGUI	G
S100 calcium-binding protein A1	S100A1	N
S100 calcium-binding protein A2	S100A2	N
S100 calcium-binding protein A3	S100A3	N
S100 calcium-binding protein A4	S100A4	N
S100 calcium-binding protein A5	S100A5	N
S100 calcium-binding protein A6	S100A6	N
S100 calcium-binding protein A7	S100A7	N
S100 calcium-binding protein A8	S100A8	N
S100 calcium-binding protein A9	S100A9	N
S100 calcium-binding protein B	S100B	N
S100 calcium-binding protein P	S100P	N
SA homolog	SAH	G
SAP (SLAM-associated protein)	SH2D1A	I
Secretase, alpha		N
Secretase, beta		N
Secretase, gamma		N
Selectin E	SELE	N
Selectin L	SELL	N
Selectin P	SELP	N
Serotonin receptor, 5HT1A	HTR1A	N

Serotonin receptor, 5HT1B	HTR1B	N
Serotonin receptor, 5HT1C	HTR1C	N
Serotonin receptor, 5HT1D	HTR1D	N
Serotonin receptor, 5HT1E	HTR1E	N
Serotonin receptor, 5HT1F	HTR1F	N
Serotonin receptor, 5HT2A	HTR2A	N
Serotonin receptor, 5HT2B	HTR2B	N
Serotonin receptor, 5HT2C	HTR2C	N
Serotonin receptor, 5HT3	HTR3	N
Serotonin receptor, 5HT4	HTR4	N
Serotonin receptor, 5HT5	HTR5	N
Serotonin receptor, 5HT6	HTR6	N
Serotonin receptor, 5HT7	HTR7	N
Serum amyloid A	SAA	T
Serum amyloid P	SAP	T
Sjogren (Sjogren) syndrome antigen A1	SSA1	I
Sodium channel, non-voltage gated 1, alpha	SCNN1A	N
Sodium channel, non-voltage gated 1, beta	SCNN1B	N
Sodium channel, non-voltage gated 1, gamma	SCNN1G	N
Sodium channel, voltage gated, type IV, alpha polypeptide	SCN4A	N
Sodium channel, voltage gated, type V, alpha polypeptide	SCN5A	N
Sodium channel, voltage-gated, type 1, beta polypeptide	SCN1B	N
Solute carrier family 1 (glutamate transporter), member 1	SLC1A1	T
Solute carrier family 1 (glutamate transporter), member 2	SLC1A2	T
Solute carrier family 10 (sodium/bile acid cotransporter family), member 1	SLC10A1	T
Solute carrier family 10 (sodium/bile acid cotransporter family), member 2	SLC10A2	T
Solute carrier family 12, member 1	SLC12A1	T
Solute carrier family 12, member 2	SLC12A2	T
Solute carrier family 12, member 3	SLC12A3	T
Solute carrier family 2 (facilitated glucose transporter), member 1	SLC2A1	T
Solute carrier family 2 (facilitated glucose transporter), member 2	SLC2A2	T
Solute carrier family 2 (facilitated glucose transporter), member 3	SLC2A3	T
Solute carrier family 2 (facilitated glucose transporter), member 4	SLC2A4	T
Solute carrier family 2 (facilitated glucose transporter), member 5	SLC2A5	T
Solute carrier family 21, member 2	SLC21A2	T

Solute carrier family 21, member 3	SLC21A3	T
Solute carrier family 22, member 5	SLC22A5	T
Solute carrier family 3 (facilitated glucose transporter), member 1	SLC3A1	T
Solute carrier family 4 (anion exchanger), member 1	SLC4A1	T
Solute carrier family 4 (anion exchanger), member 2	SLC4A2	T
Solute carrier family 4 (anion exchanger), member 3	SLC4A3	T
Solute carrier family 5 (sodium/glucose transporter), member 1	SLC5A1	T
Solute carrier family 5 (sodium/glucose transporter), member 2	SLC5A2	T
Solute carrier family 5 (sodium/glucose transporter), member 5	SLC5A5	T
Solute carrier family 5, member 3	SLC5A3	T
Solute carrier family 6 (GAMMA-AMINO BUTYRIC ACID transporter), member 1	SLC6A1	T
Solute carrier family 6 (neurotransmitter transporter, dopamine), member 3	SLC6A3	T
Solute carrier family 6 (neurotransmitter transporter, noradrenaline), member 2	SLC6A2	T
Solute carrier family 6 (neurotransmitter transporter, serotonin), member 4	SLC6A4	T
Solute carrier family 8 (sodium/calcium exchanger), member 1	SLC8A1	T
Sonic hedgehog, SHH	SHH	G
Sorcin	SRI	T
Spectrin alpha	SPTA1	S
Spectrin beta	SPTB	S
Sphingomyelinase	SMPD1	E
Stem cell factor	SCF	G
Steroid 5 alpha reductase 1	SRD5A1	E
Steroid 5 alpha reductase 2	SRD5A2	E
Steroidogenic acute regulatory protein	STAR	T
Sterol carrier protein 2	SCP2	T
Succinate dehydrogenase 1	SDH1	E
Succinate dehydrogenase 2	SDH2	E
Succinate thiokinase		E
Superoxide dismutase 1	SOD1	E
Superoxide dismutase 3	SOD3	E
Surfeit 1	SURF1	G
Synapsin 1a & 1b	SYN1	N
Synapsin 2a & 2b	SYN2	N
Synaptic vesicle amine transporter	SVAT	N
Synaptobrevin 1	SYB1	N

Synaptobrevin 2	SYB2	N
Synaptogyrin		N
Synaptophysin	SYP	N
Synaptosomal-associated protein, 25KD	SNAP25	N
Synaptotagmin 1	SYT1	N
Synaptotagmin 2	SYT2	N
Syntaxin 1	STX1	N
Talin	TLN	G
T-BOX 1	TBX1	G
T-BOX 3	TBX3	G
TEK, tyrosine kinase, endothelial	TEK	E
Terminal deoxynucleotidyltransferase	TDT	I
Tetranectin	TNA	T
Thiolase, peroxisomal		E
Thiopurine S-methyltransferase	TPMT	E
Thrombin receptor	F2R	I
Thrombomodulin	THBD	I
Thrombopoietin	THPO	G
Thrombospondin	THBS1	G
Thromboxane A synthase 1	TBXAS1	I
Thromboxane A2	TXA2	I
Thromboxane A2 receptor	TBXA2R	I
Thy-1 T-cell antigen	THY1	I
Thymic humoral factor		I
Thymopoietin	TMPO	G
Thymosin		I
Thyroid hormone receptor, alpha	THRA	G
Thyroid hormone receptor, beta	THRB	G
TIE receptor tyrosine kinase	TIE-1	G
Tip-associated protein	TAP	I
Tissue inhibitor of metalloproteinase 1, TIMP1	TIMP1	E
Tissue inhibitor of metalloproteinase 2, TIMP2	TIMP2	E
Tissue inhibitor of metalloproteinase 3, TIMP3	TIMP3	E
Tissue inhibitor of metalloproteinase 4, TIMP4	TIMP4	E
Topoisomerase I		E
Torticollis, keloids, cryptorchidism and renal dysplasia gene	TKCR	G
Transcobalamin 2, TCN2	TCN2	T
Transcription factor 2, hepatic	TCF2	G
Transferrin	TF	G
Transferrin receptor	TFRC	G
Transforming growth factor, beta 2	TGFB2	G
Transforming growth factor, beta induced	TGFB1	G
Transforming growth factor, beta receptor 2	TGFR2	G



Translocation in renal carcinoma on chromosome 8 gene	TRC8	G
Transthyretin	TTR	T
Triosephosphate isomerase	TPI1	E
Tropomyosin 1 alpha	TPM1	S
Troponin C		S
Troponin I	TNNI3	S
Troponin T2, cardiac	TNNT2	S
Tuberous sclerosis 1	TSC1	G
Tuberous sclerosis 2	TSC2	G
Tumour necrosis factor (TNF) receptor associated factor 1	TRAF1	I
Tumour necrosis factor (TNF) receptor associated factor 2	TRAF2	I
Tumour necrosis factor (TNF) receptor associated factor 3	TRAF3	I
Tumour necrosis factor (TNF) receptor associated factor 4	TRAF4	I
Tumour necrosis factor (TNF) receptor associated factor 5	TRAF5	I
Tumour necrosis factor (TNF) receptor associated factor 6	TRAF6	I
Tumour necrosis factor alpha	TNFA	I
Tumour necrosis factor alpha receptor	TNFAR	I
Tumour necrosis factor beta	TNFB	I
Tumour necrosis factor beta receptor	TNFBR	I
Tumour protein p53	TP53, P53	G
Tumour protein p63	TP63	G
Tyrosine hydroxylase	TH	E
Ubiquitin		G
Ubiquitin B	UBB	G
Ubiquitin C	UBC	G
UDP-glucose pyrophosphorylase		E
UDP-glucuronosyltransferase 1	ugt1d, UGT1	E
UDP-glucuronosyltransferase 2	UGT2	E
Uncoupling protein 1		T
Uncoupling protein 3	UCP3	T
Undulin 1	COL14A1	S
Uridinediphosphate(UDP)-galactose-4-epimerase	GALE	E
Uroporphyrinogen III synthase	UROS	E
Vacuolar proton pump, subunit 1	VPP1	N
Vacuolar proton pump, subunit 3	VPP3	N
Vascular endothelial growth factor	VEGF	G
Vasoactive intestinal polypeptide	VIP	N
Vasoactive intestinal polypeptide receptor	VIPR	N
Vasoinhibitory peptide		G
Vimentin	VIM	I

Vinculin		S
Vitamin D receptor	VDR	G
Von Hippel-Lindau gene	VHL	G
Von Willebrand factor	VWF	T
Werner syndrome helicase	WRN	G
Wiskott-Aldrich syndrome protein	WASP, THC	I
Wolf-Hirschhorn syndrome candidate 1 gene	WHSC1	G
Wolfram syndrome 1 gene	WFS1	S
Xanthine dehydrogenase	XDH	E
Zinc finger protein 3	ZIC3	S

In a ninth aspect.

## GASTROINTESTINAL

The present invention relates to a method of assessing the risk of developing clinical or social consequences of dysfunction, damage or disease of the gastrointestinal tract and indicating appropriate therapeutic interventions.

The gastrointestinal tract stores, digests and absorbs nutrients from foodstuffs and eliminates body wastes. The gastrointestinal tract comprises the mouth and salivary glands, oesophagus, stomach, small intestine, large intestine, colon and rectum. In addition the liver, pancreas, kidney, gall bladder and biliary tract also have major roles in the enabling and co-ordination of gastrointestinal function (Weatherall, Leadingham and Warrell 1996).

The regulation of gastrointestinal function is achieved by an extensive series of monitoring and feedback systems which include the intrinsic nerves of the enteric nervous system, vagal and sympathetic nerves, neuropeptides, hormones and transmitters. Together these diverse systems act to link the central nervous system and the components of the gastrointestinal tract in order to co-ordinate and control the processes regulating the absorption of nutrients and the elimination of wastes.

The digestive and absorptive process involved in obtaining nutrients from food stuff and the physical processes involved in the elimination of wastes have given rise to the specialised functions of gastrointestinal tissues. Nutrients in foodstuffs need to be solubilised in order for them to be absorbed across the gut wall. Teeth, tongue and the acid environment of the stomach are important in liquidising semi-solid foodstuffs, thus allowing the breakdown of their constituent molecules into extractable nutrients. Because foodstuffs contain potential pathogens and toxins the gut wall must be capable of defending and repairing itself and the gastrointestinal tract must have a system for rendering harmless potential toxins (the liver). The physical processes involved in moving the liquidised foodstuffs through the gastrointestinal tract involve the integration of muscular activity (circular and longitudinal muscles) such that flow of foodstuffs and subsequent wastes is smooth and largely unidirectional through the system.

Dysfunction, damage or disease of the gastrointestinal tract is characterised by a relatively circumscribed range of symptoms including:

Dysphagia

Vomiting

Mouth, neck or abdominal pain

Diarrhoea

Constipation

Gastrointestinal bleeding

Nutritional disorders

The diverse nature of the component organs which make up the gastrointestinal tract is mirrored in the range of pathological mechanisms which underlie dysfunction,

damage and disease of the gastrointestinal tract. The syndromes and causes of dysfunction, damage and disease of the gastrointestinal system include:

Dental caries

Ulceration (e.g. mouth, gastric, intestinal)

Infection (e.g. herpes simplex, AIDS, helicobacter pylori, hepatitis, shigella)

Reflux disease

Smooth muscle disease (e.g. scleroderma)

Striated muscle disorders (e.g. inclusion body myositis)

Tumours

Malnutrition

Malabsorption (e.g. coeliac disease, Whipples disease)

Congenital abnormalities (e.g. oesophageal artresia, Carcli's syndrome)

Immune disorders (e.g. allergies, Crohn's disease, ulcerative colitis, irritable bowel syndrome)

Disorders of neuronal innervation (Hirschprung's disease)

Vascular and collagen disorders

Genetic disorders (e.g. haemochromatosis, galactosaemia, Niemann-Pick disease)

Bacterial overgrowth

Toxins/poisons

Drug use and abuse (e.g. Tacrine, Troglitazone, Paracetamol)

The range of pathology and thus the impact of such pathology on an individual's quality of life is very broad. A heavy meal can cause a brief episode of discomfort due to excess stomach acid and is easily remedied by taking an appropriate antidote, whereas tumour metastases affecting the liver compromise the de-toxification systems of the body and are a life threatening event. In addition, because the preferred route of administering drug therapy is by the oral route (thus exposing the gastrointestinal system to the drug and relying on absorption through the gut for entry into the body) the pharmacokinetics of many therapeutic interventions are altered by gastrointestinal functionality and associated with adverse events characterised by the symptoms of nausea, diarrhoea etc (Brody, Larner and Minneman 1998, British National Formulary 1998).

The physiology and control of the body's gastrointestinal system is extremely complex and involves the synergistic or inhibitory interaction between multiple regulatory pathways and molecular cascades. Variation in the functionality of the proteins involved in these processes will, inevitably, cause or have an impact on the functioning of these systems or an individuals attempts to minimise damage and restore function following dysfunction, damage or disease in these systems. A number of constitutional factors are known to impact on the individuals ability to deal with and recover from dysfunction, damage or disease of the gastrointestinal tract including genetic history, age, sex, nutritional status, pre-existing disease or injury, drug treatments and socio-economic circumstances. Genetic variation within individuals is also a key factor although the extent and nature of the genes involved and their precise impact on prognosis, complications, efficacy of therapeutic intervention and eventual recovery of function is largely unknown.

The individual variability in response to the occurrence of gastrointestinal pathology

and the associated variation in symptomatology, response to therapy and adverse events resulting from therapeutic interventions lies at the heart of the difficulties experienced in the healthcare and social management of dysfunction, damage or disease of the gastrointestinal tract.

We have elaborated on the value and utility to be derived from the gathering together of the genes which form the core gene list for this particular Genostic system.

These genes are elaborated below:

#### KEY TO 'PROTEIN FUNCTION' COLUMN

E ENZYME  
T TRANSPORT & STORAGE  
S STRUCTURAL  
I IMMUNITY  
N NERVOUS TRANSMISSION  
G GROWTH & DIFFERENTIATION

#### GASTROINTESTINAL GENE LIST

	HUGO gene symbol	Protein function
11beta hydroxysteroid dehydrogenase 2	HSD11B2	E
17beta hydroxysteroid dehydrogenase 1	HSD17B1	E
17beta hydroxysteroid dehydrogenase 3	HSD17B3	E
17beta hydroxysteroid dehydrogenase 4	HSD17B4	E
17beta hydroxysteroid oxidoreductase		E
2,3-bisphosphoglycerate mutase	BPGM	E
3 beta hydroxysteroid dehydrogenase 2	HSD3B2	E
6-phosphofructo-2-kinase	PFKFB1	E
Acetoacetyl 1-CoA-thiolase	ACAT1	E
Acetoacetyl 2-CoA-thiolase	ACAT2	E
Acetyl CoA carboxylase	ACC	E
Acetyl CoA carboxylase alpha	ACACA	E
Acetylcholine receptor, nicotinic, gamma	CHRNA7	N
Acetylcholinesterase	ACHE	E
Acid phosphatase 2, lysosomal	ACP2	E
Actin, alpha, cardiac	ACTC	S
Actin, alpha, skeletal	ACTA1	S
Actin, alpha, smooth, aortic	ACTA2	S
Actin, beta	ACTB	S
Actin, gamma 2	ACTG2	S
Acyl CoA dehydrogenase, long chain	ACADL	E
Acyl CoA dehydrogenase, medium chain	ACADM	E
Acyl CoA dehydrogenase, short chain	ACADS	E
Acyl CoA dehydrogenase, very long chain	ACADVL	E
Acyl CoA synthetase, long chain, 1	LACS1	E
Acyl CoA synthetase, long chain, 2	LACS2	E
Acyl CoA synthetase, long chain, 4	ACS4	E

Acyl malonyl condensing enzyme		E
Acyl-CoA thioesterase		E
Adaptin, beta 3A	ADTB3A	T
Adenine phosphoribosyltransferase	APRT	T
Adenomatous polyposis coli tumour suppressor gene	APC	G
Adenosine receptor A1	ADORA1	N
Adenosine receptor A2A	ADORA2A	N
Adenosine receptor A2B	ADORA2B	N
Adenosine receptor A3	ADORA3	N
Adenylate cyclase 1	ADCY1	E
Adenylate cyclase 2	ADCY2	E
Adenylate cyclase 3	ADCY3	E
Adenylate cyclase 4	ADCY4	E
Adenylate cyclase 5	ADCY5	E
Adenylate cyclase 6	ADCY6	E
Adenylate cyclase 7	ADCY7	E
Adenylate cyclase 8	ADCY8	E
Adenylate cyclase 9	ADCY9	E
Adrenergic receptor, alpha1	ADRA1	N
Adrenergic receptor, alpha2	ADRA2	N
Adrenergic receptor, beta1	ADRB1	N
Adrenergic receptor, beta2	ADRB2	N
Adrenergic receptor, beta3	ADRB3	N
Adrenocorticotrophic hormone (ACTH) receptor	ACTHR	G
Alanine aminotransferase		T
Alanine-glyoxylate aminotransferase	AGXT	E
Albumin, ALB	ALB	T
Alcohol dehydrogenase 1	ADH1	E
Alcohol dehydrogenase 2	ADH2	E
Alcohol dehydrogenase 3	ADH3	E
Alcohol dehydrogenase 4	ADH4	E
Alcohol dehydrogenase 5	ADH5	E
Alcohol dehydrogenase 6	ADH6	E
Alcohol dehydrogenase 7	ADH7	E
Aldehyde dehydrogenase 1	ALDH1	E
Aldehyde dehydrogenase 2	ALDH2	E
Aldehyde dehydrogenase 5	ALDH5	E
Aldehyde dehydrogenase 6	ALDH6	E
Aldehyde dehydrogenase 7	ALDH7	E
Aldolase A	ALDOA	E
Aldolase B	ALDOB	E
Aldolase C	ALDOC	E
Aldose reductase		T
Aldosterone receptor	MLR	G
Alkaline phosphatase, liver/bone/kidney	ALPL	T
Alpha 2 macroglobulin	A2M	I

alpha1-antitrypsin	PI	E
alpha2-antiplasmin	PLI	E
alpha-actinin 2	ACTN2	G
alpha-actinin 3	ACTN3	G
alpha-amylase		E
alpha-dextrinase		E
alpha-Galactosidase A	GLA	E
alpha-ketoglutarate dehydrogenase		E
alpha-L-Iduronidase	IDUA	E
Aminomethyltransferase	AMT	E
Aminopeptidase P	XPNPEP2	E
Amphiregulin	AREG	G
Amylo-1,6-glucosidase	AGL	E
Angiopoietin 1	ANGPT1	G
Angiopoietin 2	ANGPT2	G
Angiotensin converting enzyme	ACE, DCP1	E
Angiotensin receptor 1	AGTR1	T
Angiotensin receptor 2	AGTR2	T
Angiotensinogen	AGT	E
Antidiuretic hormone receptor	ADHR	T
Antithrombin III	AT3	E
AP-2, alpha	TFAP2A	G
AP-2, beta	TFAP2B	G
AP-2, gamma	TFAP2C	G
Apolipoprotein A I	APOA1	T
Apolipoprotein A II	APOA2	T
Apolipoprotein B	APOB	T
Apolipoprotein C1	APOC1	T
Apolipoprotein C2	APOC2	T
Apolipoprotein C3	APOC3	T
Apolipoprotein D	APOD	T
Apolipoprotein E	APOE	T
Apolipoprotein H	APOH	T
Aquaporin 1	AQP1	T
Aquaporin 2	AQP2	T
Arginine vasopressin	AVP	N
Arginine vasopressin receptor 1A	AVPR1A	N
Arginine vasopressin receptor 1B	AVPR1B	N
Arginine vasopressin receptor 2	AVPR2	N
Arginosuccinate lyase	ASL	E
Arginosuccinate synthetase	ASS	E
Aryl hydrocarbon receptor nuclear translocator	ARNT	T
Arylsulfatase A	ARSA	E
Arylsulfatase B	ARSB	E
Aspartate transaminase		T
Aspartylglucosaminidase	AGA	E
Ataxia telangiectasia gene, AT	ATM	G
ATP/ADP translocase		E

Atrial natriuretic peptide	ANP	G
Atrial natriuretic peptide receptor A	NPR1	G
Atrial natriuretic peptide receptor B	NPR2	G
Atrial natriuretic peptide receptor C	NPR3	G
Autoimmune regulator, AIRE	AIRE	I
Azoospermia factor 1	AZF1	G
beta 2 microglobulin	B2M	I
beta-galactosidase	GLB1	E
beta-glucosidase, neutral		E
beta-Glucuronidase	GUSB	E
beta-ketoacyl reductase		E
Bile acid coenzyme A: amino acid N-acyltransferase	BAAT	E
Bile salt export pump	BSEP, PFIC2	T
Bile salt-stimulated lipase	CEL	E
Bilirubin UDP-glucuronosyltransferase		E
Biliverdin reductase		T
Bradykinin receptor B1		I
Bradykinin receptor B2		I
Branched chain keto acid dehydrogenase E1, alpha polypeptide	BCKDHA	E
Branched chain keto acid dehydrogenase E1, beta polypeptide	BCKDHB	E
Brush border guanylyl cyclase		E
Ca(2+) transporting ATPase, fast twitch	ATP2A1	T
Ca(2+) transporting ATPase, slow twitch	ATP2A2	T
Cadherin E	CDH1	G
Cadherin EP		G
Cadherin N	CDH2	G
Cadherin P	CDH3	G
Calcitonin/Calcitonin gene-related peptide alpha	CALCA	N
Calcium channel, voltage-dependent, alpha 1F subunit	CACNA1F	N
Calcium channel, voltage-dependent, Alpha-1B (CACNL1A5)	CACNA1B	N
Calcium channel, voltage-dependent, Alpha-1C	CACNA1C	N
Calcium channel, voltage-dependent, Alpha-1D	CACNA1D	N
Calcium channel, voltage-dependent, Alpha-1E (CACNL1A6)	CACNA1E	N
Calcium channel, voltage-dependent, Alpha-2/delta	CACNA2	N
Calcium channel, voltage-dependent, Beta 1	CACNB1	N
Calcium channel, voltage-dependent, Beta 3	CACNB3	N
Calcium channel, voltage-dependent, Neuronal, Gamma	CACNG2	N



Calcium channel, voltage-dependent, T-type		N
Calcium sensing receptor	CASR	T
Calmodulin 1	CALM1	G
Calmodulin 2	CALM2	G
Calmodulin 3	CALM3	G
Calmodulin dependant kinase		T
Calmodulin-dependant protein kinase II	CAMK2A	G
Calnexin	CANX	G
Canalicular multispecific organic anion transporter	CMOAT	T
Carbamoylphosphate synthetase 1	CPS1	E
Carbamoylphosphate synthetase 2	CPS2	E
Carbonic anhydrase 3	CA3	E
Carbonic anhydrase 4	CA4	E
Carbonic anhydrase, alpha	CA1	E
Carbonic anhydrase, beta	CA2	E
Carboxylesterase 1	CES1	E
Carboxypeptidase	CPN	E
Carnitine acylcarnitine translocase	CACT	E
Carnitine palmitoyltransferase I	CPT1A	E
Carnitine palmitoyltransferase II	CPT2	E
Carnitine transporter protein	CDSP, SCD	T
Cartilage-hair hypoplasia gene	CHH	N
Catalase	CAT	I
Cathepsin B		E
Cathepsin D		E
Cathepsin E		E
Cathepsin G	CTSG	E
Cathepsin H		E
Cathepsin K	CTSK	E
Cathepsin L		E
Cathepsin S		E
CD1	CD1	I
CD4	CD4	I
Cell adhesion molecule, intercellular, ICAM	ICAM1	G
Cell adhesion molecule, leukocyte-endothelial, LECAM (CD62)	LECAM1	G
Cell adhesion molecule, liver, LCAM	LCAM	G
Cell adhesion molecule, neural, NCAM1	NCAM1	G
Cell adhesion molecule, neural, NCAM120	NCAM120	G
Cell adhesion molecule, neural, NCAM2	NCAM2	G
Cell adhesion molecule, platelet-endothelial, PECAM	PECAM1	G
Cell adhesion molecule, vascular, VCAM	VCAM1	G
c-erbB2	ERBB2	G
c-erbB3	ERBB3	G
c-erbB4	ERBB4	G
Ceruloplasmin precursor	CP	E

Chemokine receptor CCR2	CCR2	I
Chemokine receptor CCR3	CCR3	I
Chemokine receptor CCR5	CCR5	I
Chemokine receptor CXCR4	CXCR4	I
Chitotriosidase	chit	E
Chloride channel 5	CLCN5	S
Chloride channel KB	CLCNKB	S
Cholecystokinin	CCK	N
Cholecystokinin B receptor	CCKBR	N
Cholestasis, progressive familial intrahepatic 1 gene	FIC1	G
Cholesterol ester hydroxylase		E
Choline acetyltransferase	CHAT	E
Chromogranin A	CHGA	G
Chymotrypsinogen		E
Citrate synthase		E
Clathrin		T
Clusterin	CLU	G
CoA transferase		E
Cockayne syndrome gene, CKN1	CKN1	G
Collagen I alpha 1	COL1A1	S
Collagen I alpha 2	COL1A2	S
Collagen II alpha 1	COL2A1	S
Collagen III alpha 1	COL3A1	S
Collagen IV alpha 1	COL4A1	S
Collagen IV alpha 2	COL4A2	S
Collagen IV alpha 3	COL4A3	S
Collagen IV alpha 4	COL4A4	S
Collagen IV alpha 5	COL4A5	S
Collagen IV alpha 6	COL4A6	S
Collagen IX alpha 2	COL9A2, EDM2	S
Collagen IX alpha 3	COL9A3	S
Collagen receptor	COLR	S
Collagen V alpha 1	COL5A1	S
Collagen V alpha 2	COL5A2	S
Collagen VI alpha 1	COL6A1	S
Collagen VI alpha 2	COL6A2	S
Collagen VI alpha 3	COL6A3	S
Collagen VII alpha 1	COL7A1	S
Collagen X alpha 1	COL10A1	S
Collagen X alpha 1	COL11A1	S
Collagen XI alpha 2	COL11A2	S
Collagen XVII alpha 1	COL17A1	S
Colony-stimulating factor 1	CSF1	G
Complement component C1 inhibitor	C1NH	I
Complex I		E
Complex II		E
Complex III		E

Corticotrophin-releasing hormone	CRH	T
Corticotrophin-releasing hormone receptor	CRHR1	T
C-reactive protein CRP		I
Creb binding protein	CREBBP	G
Cu <sup>2+</sup> transporting ATPase beta polypeptide	ATP7B	E
Cubilin	CUBN	T
Cyclic AMP-dependent protein kinase	PKA	E
Cyclic nucleotide phosphodiesterase 1B	PDE1B	E
Cyclic nucleotide phosphodiesterase 1B1	PDE1B1	E
Cyclic nucleotide phosphodiesterase 2A3	PDE2A3	E
Cyclic nucleotide phosphodiesterase 3A	PDE3A	E
Cyclic nucleotide phosphodiesterase 3B	PDE3B	E
Cyclic nucleotide phosphodiesterase 4A	PDE4A	E
Cyclic nucleotide phosphodiesterase 4C	PDE4C	E
Cyclic nucleotide phosphodiesterase 5A	PDE5A	E
Cyclic nucleotide phosphodiesterase 6A	PDE6A	E
Cyclic nucleotide phosphodiesterase 6B	PDE6B	E
Cyclic nucleotide phosphodiesterase 7	PDE7	E
Cyclic nucleotide phosphodiesterase 8	PDE8	E
Cyclic nucleotide phosphodiesterase 9A	PDE9A	E
Cyclin F	CCNF	G
Cyclin-dependent kinase 2	CDK2	G
Cyclin-dependent kinase inhibitor 1C (P57, KIP2)	CDKN1C	G
Cyclooxygenase 1	COX1	E
Cyclooxygenase 2	COX2	E
CYP11A1	CYP11A1	E
CYP11B1	CYP11B1	E
CYP11B2	CYP11B2	E
CYP17	CYP17	E
CYP19	CYP19	E
CYP1A1	CYP1A1	E
CYP1A2	CYP1A2	E
CYP1B1	CYP1B1	E
CYP21	CYP21	E
CYP24	CYP24	E
CYP27	CYP27	E
CYP27B1	PDDR	E
CYP2A1	CYP2A1	E
CYP2A13	CYP2A13	E
CYP2A3	CYP2A3	E
CYP2A6V2	CYP2A6V2	E
CYP2A7	CYP2A7	E
CYP2B6	CYP2B6	E
CYP2C18	CYP2C18	E
CYP2C19	CYP2C19	E
CYP2C8	CYP2C8	E
CYP2C9	CYP2C9	E

CYP2D6	CYP2D6	E
CYP2E1	CYP2E1	E
CYP2F1	CYP2F1	E
CYP2J2	CYP2J2	E
CYP3A3	CYP3A3	E
CYP3A4	CYP3A4	E
CYP3A5	CYP3A5	E
CYP3A7	CYP3A7	E
CYP4A11	CYP4A11	E
CYP4B1	CYP4B1	E
CYP4F2	CYP4F2	E
CYP4F3	CYP4F3	E
CYP51	CYP51	E
CYP5A1	CYP5A1	E
CYP7A	CYP7A	E
CYP8	CYP8	E
Cystathionase	CTH	E
Cystathione beta synthase	CBS	E
Cysteine-rich intestinal protein		T
Cystic fibrosis transmembrane conductance regulator, CFTR	CFTR	N
Cystinosin	CTNS	T
Cytidine deaminase	CDA	E
Cytidine-5-prime-triphosphate synthetase	CTPS	E
Cytochrome a		E
Cytochrome c		E
Cytochrome c oxidase, MTCO		E
Cytokine-suppressive antiinflammatory drug- binding protein 1	CSBP1	I
Cytokine-suppressive antiinflammatory drug- binding protein 2	CSBP2	I
DAX1 nuclear receptor	DAX1	I
Deleted in colorectal carcinoma	DCC	G
Delta aminolevulinate dehydratase	ALAD	E
Delta(4)-3-oxosteroid 5-beta-reductase		E
Delta-7-dehydrocholesterol reductase	DHCR7	E
Dihydrodiol dehydrogenase 1	DDH1	E
Dihydrolipoamide branched chain transacylase	DBT	N
Dihydrolipoamide dehydrogenase	DLD	N
DNA glycosylases		E
Dopamine beta hydroxylase	DBH	E
Dopamine receptors D1	DRD1	N
Dopamine receptors D2	DRD2	N
Dopamine receptors D3	DRD3	N
Dopamine receptors D4	DRD4	N
Dopamine receptors D5	DRD5	N
Dynamin	DNM1	G
Dynein		G

Dystrophia myotonica	DM, DMPK	E
Dystrophia myotonica, atypical	DM2	E
Dystrophin	DMD	S
EB1		G
Elastase 1	ELAS1	E
Elastase 2	ELAS2	E
Electron-transferring-flavoprotein alpha	ETFA	T
Electron-transferring-flavoprotein beta	ETFB	T
Electron-transferring flavoprotein dehydrogenase	ETFDH	E
Endothelin 1	EDN1	N
Endothelin 2	EDN2	N
Endothelin 3	EDN3	N
Endothelin converting enzyme	ECE1	N
Endothelin receptor type A	EDNRA	N
Endothelin receptor type B	EDNRB	N
Enolase	ENO1	E
Enoyl CoA isomerase		E
Enoyl CoA reductase		E
Enteric lipase		T
Enterokinase	PRSS7, ENTK	E
Ephrin receptor tyrosine kinase A	EPHA	G
Ephrin receptor tyrosine kinase B	EPHB	G
Epidermal growth factor	EGF	G
Epidermal growth factor receptor	EGFR	G
Erythrocyte membrane protein band 4.1	EPB41	S
Erythropoietin	EPO	I
Excision repair complementation group 2 protein	ERCC2	E
Excision repair complementation group 2 protein	ERCC3	E
Eyes absent 1	EYA1	G
Faciogenital dysplasia	FGD1, FGDY	T
Factor 1 (No. one)	F1	I
Factor B, properdin		I
Factor D		I
Factor H	HF1	I
Factor I (letter I)	IF	I
Factor III	F3	I
Factor IX	F9	I
Factor V	F5	I
Factor VII	F7	I
Factor VIII	F8	I
Factor X	F10	I
Factor XI	F11	I
Factor XII	F12	I
Factor XIII A & B	F13A & F13B	I
FADH dehydrogenase		E

Fanconi anemia, complementation group A	FANCA	T
Fanconi anemia, complementation group C	FANCC	T
Fanconi anemia, complementation group D	FANCD	T
Fatty acid binding proteins FABP1		T
Fatty acid binding proteins FABP2	FABP2	T
Fatty acid binding proteins FABP3		T
Fatty acid binding proteins FABP4		T
Fatty acid binding proteins FABP5		T
Fatty acid binding proteins FABP6		T
Ferritin, H subunit		T
Ferritin, L subunit	FTL	T
Fibroblast growth factor	FGF1	G
Fibroblast growth factor receptor 1	FGFR1	G
Fibroblast growth factor receptor 2	FGFR2	G
Fibroblast growth factor receptor 3	FGFR3	G
Fibronectin precursor	FN1	G
Flavin-containing monooxygenase 1	FMO1	E
Flavin-containing monooxygenase 2	FMO2	E
Flavin-containing monooxygenase 3	FMO3	E
Flavin-containing monooxygenase 4	FMO4	E
Folic acid receptor	FOLR	G
Follicle stimulating hormone receptor	FSHR, ODG1	G
Follicle stimulating hormone, FSH	FSHB	G
Forkhead transcription factor 10	FKHL10	G
Forkhead transcription factor 14	FKHL14	G
Fragile site, folic acid type, rare, fra(X) A	FRAXA	N
Fructose-1,6-diphosphatase	FBP1	E
Fucosidase alpha-L-1	FUCA1	E
Fucosidase alpha-L-2		E
Fucosyltransferase 2	FUT2	T
Fucosyltransferase 3	FUT3	T
Fumarase	FH	E
G/T mismatch binding protein	GTBP, MSH6	G
Galactocerebrosidase	GALC	E
Galactose 1-phosphate uridyl-transferase	GALT	E
Galactosyltransferase 1	GT1	G
Galactosyltransferase, alpha 1,3	GGTA1	G
Galactosyltransferase, beta 3	B3GALT	G
Galanin	GAL	N
Galanin receptor	GALNR1	N
Gamma-glutamyltransferase 1	GGT1	T
Gamma-glutamyltransferase 2	GGT2	T
Gap junction protein beta 1	GJB1	T
Gastric inhibitory polypeptide GIP	GIP	T
Gastric inhibitory polypeptide receptor, GIPR	GIPR	T
Gastric Intrinsic factor, GIF	GIF	E
Gastric lipase, LIPF		T
Gastrin	GAS	G

Gastrin releasing peptide	GRP	T
Gastrin releasing peptide receptor	GRPR	T
Glial-cell derived neurotrophic factor (GDNF) receptor		N
Glial-cell derived neurotrophic factor, GDNF	GDNF	N
Glucagon receptor	GCGR	G
Glucagon synthase		T
Glucagon-like peptide receptor 1	GLP1R	G
Glucokinase	GCK	E
Glucose-6-phosphatase	G6PC	E
Glucose-6-phosphatase translocase	G6PT1	E
Glucose-6-phosphate dehydrogenase	G6PD	E
Glucosidase, acid alpha	GAA	E
Glutamate dehydrogenase	GLUD1	E
Glutamine synthase		E
Glutamine transporter		T
Glutathione	GSH	T
Glutathione peroxidase, GPX2	GPX2	E
Glutathione S-transferase, GSTZ1	GSTZ1	E
Glyceraldehyde-3-phosphate dehydrogenase, GAPDH	GAPDH	E
Glycerol kinase	GK	E
Glycinamide ribonucleotide (GAR) transformylase	GART	E
Glycine dehydrogenase	GLDC	E
Glycogen branching enzyme	GBE1	E
Glycogen phosphorylase	PYGL	E
Glycogen synthase 1 (muscle)	GLYS1	E
Glycogen synthase 2 (liver)	GYS2	E
Glycosyltransferases, ABO blood group	ABO	E
Gonadotropin releasing hormone	GNRH	G
Goosecoid GSC		G
Growth arrest-specific homeobox	GAX	G
Growth hormone receptor	GHR	G
Guanylin	GUCA2	T
H(+), K(+) - ATPase	ATP4B	N
Haem oxygenase		T
Haemoglobin alpha 1	HBA1	T
Haemoglobin alpha 2	HBA2	T
Haemoglobin beta	HBB	T
Haemoglobin delta	HBD	T
Haemoglobin gamma A	HBG1	T
Haemoglobin gamma B	HBG2	T
Haemoglobin gamma G	HBGG	T
Heat shock protein, HSP60		I
Heat shock protein, HSP70		I
Heat shock protein, HSP90		I
Heat shock protein, HSPA1		I

Heat shock protein, HSPA2		I
Heparan sulfamidase		E
Heparin binding epidermal growth factor	HBEGF	G
Heparin Cofactor II	HCF2	I
Hepatic nuclear factor-3-beta	HNF3B	E
Hepatic nuclear factor-4-alpha	HNF4A	E
Hepatitis B virus integration site 1	HVBS1	I
Hepatitis B virus integration site 2	HVBS6	I
Hepatocyte growth factor	HGF	G
Hermansky-pudlak syndrome gene	HPS	T
Hexokinase 1	HK1	E
Hexokinase 2	HK2	E
Hexosaminidase A	HEXA,TSD	E
Hexosaminidase B	HEXB	E
Histamine receptors, H1		N
Histamine receptors, H2		N
Histamine receptors, H3		N
Histatin 1		I
Histatin 2		I
Histatin 3	HTN3	I
HLA-B associated transcript 1	BAT1	I
HMG-CoA lyase	HMGCL	E
HMG-CoA reductase	HMGCR	E
HMG-CoA synthase	HMGCS2	E
Holocarboxylase synthetase	HLCS	E
Hormone-sensitive lipase	HSL	E
Hydroxyacyl glutathione hydrolase	HAGH	E
Hypoxanthine-guanine phosphoribosyltransferase, HGPRT	HPRT	E
IC7 A and B		I
Iduronate 2 sulphatase	IDS	E
Immunoglobulin E (IgE) responsiveness gene	IGER	I
Immunoglobulin E (IgE) serum concentration regulator gene	IGES	I
Immunoglobulin gamma (IgG) 2	IGHG2	I
Immunoglobulin heavy mu chain	IGHM	I
Immunoglobulin J polypeptide	IGJ	I
Immunoglobulin kappa constant region	IGKC	I
Immunoglobulin kappa variable region	IGKV	I
Inhibin, alpha	INHA	G
Inhibin, beta A	INHBA	G
Inhibin, beta B	INHBB	G
Inhibin, beta C	INHBC	G
Inositol 1,4,5-triphosphate receptor 3	ITPR3	G
Insulin	INS	G
Insulin receptor	INSR	G
Insulin-like growth factor 1	IGF1	G
Insulin-like growth factor 1 receptor	IGF1R	G



Insulin-like growth factor 2	IGF2	G
Insulin-like growth factor 2 receptor	IGF2R	G
Integrin beta 1	ITGB1	G
Integrin beta 2	ITGB2	G
Integrin beta 3	ITGB3	G
Integrin beta 6	ITGB6	G
Integrin, alpha M	ITGAM	G
Integrin, alpha X	ITGAX	G
Inter-alpha-trypsin inhibitor, IAT1		E
Interferon alpha	IFNA1	I
Interferon beta	IFNB	I
Interferon gamma	IFNG	I
Interferon gamma receptor 1	IFNGR1	I
Interferon gamma receptor 2	IFNGR2	I
Interferon regulatory factor 1	IRF1	I
Interferon regulatory factor 4	IRF4	I
Interleukin(IL) 1 receptor	IL1R	I
Interleukin(IL) 1, alpha	IL1A	I
Interleukin(IL) 1, beta	IL1B	I
Interleukin(IL) 10	IL10	I
Interleukin(IL) 10 receptor	IL10R	I
Interleukin(IL) 11	IL11	I
Interleukin(IL) 11 receptor	IL11R	I
Interleukin(IL) 12	IL12	I
Interleukin(IL) 12 receptor, beta 1	IL12RB1	I
Interleukin(IL) 13	IL13	I
Interleukin(IL) 13 receptor	IL13R	I
Interleukin(IL) 2	IL2	I
Interleukin(IL) 2 receptor, alpha	IL2RA	I
Interleukin(IL) 2 receptor, gamma	IL2RG	I
Interleukin(IL) 3	IL3	I
Interleukin(IL) 3 receptor	IL3R	I
Interleukin(IL) 4	IL4	I
Interleukin(IL) 4 receptor	IL4R	I
Interleukin(IL) 5	IL5	I
Interleukin(IL) 5 receptor	IL5R	I
Interleukin(IL) 6	IL6	I
Interleukin(IL) 6 receptor	IL6R	I
Interleukin(IL) 7	IL7	I
Interleukin(IL) 7 receptor	IL7R	I
Interleukin(IL) 8	IL8	I
Interleukin(IL) 8 receptor	IL8R	I
Interleukin(IL) 9	IL9	I
Interleukin(IL) 9 receptor	IL9R	I
Interleukin(IL) receptor antagonist 1	IL1RN, IL1RA	I
Intestinal alkaline phosphatase IAP		T
Islet amyloid polypeptide	IAPP	N
Isocitrate dehydrogenase		E

Isovaleric acid CoA dehydrogenase	IVD	E
Kallikrein 3	KAK3	I
Kallman syndrome gene 1	KAL1	G
Ketohexokinase	KHK	E
ketolase		E
Kininogen, High molecular weight	KNG	I
Kynurenine hydroxylase		E
Kynureninase		E
Lactase		E
Laminin 5, alpha 3	LAMA3	G
Laminin 5, beta 3	LAMB3	G
Laminin 5, gamma 2	LAMC2	G
Laminin M	LAMM	G
Laminin receptor 1	LAMR1	G
Latent transforming growth factor-beta binding protein 2	LTBP2	G
Lecithin-cholesterol acyltransferase	LCAT	E
Leptin	LEP	G
Leptin receptor	LEPR	G
Leukocyte-specific transcript 1	LST-1	I
Leukotriene A4 hydrolase		I
Leukotriene A4 synthase	LTA4S	E
Leukotriene B4 receptor		I
Leukotriene B4 synthase	LTB4S	E
Leukotriene C4 receptor		I
Leukotriene C4 synthase	LTC4S	E
Leukotriene D4/E4 receptor		I
LIM homeobox protein 1	LHX1	G
LIM homeobox transcription factor 1, beta	LMX1B	G
Lipoamide dehydrogenase	OGDH	E
Lipoprotein lipase	LPL	I
Lipoprotein receptor, Low Density	LDLR	T
Lipoprotein, High Density	HDLDT1	T
Lipoprotein, Intermediate Density		T
Lipoprotein, Low Density 1		T
Lipoprotein, Low Density 2		T
Lipoprotein, Very Low Density	VLDLR	T
Low density lipoprotein receptor-related protein precursor	LRP	T
Lymphoid enhancer-binding factor	LEF-1	G
Lysosomal acid lipase	LIPA	E
Lysozyme	LYZ	I
MAD (mothers against decapentaplegic, Drosophila) homologue 4	MADH4	G
MADS box transcription-enhancer factor 2A	MEF2A	G
MADS box transcription-enhancer factor 2B	MEF2B	G
MADS box transcription-enhancer factor 2C	MEF2C	G
MADS box transcription-enhancer factor 2D	MEF2D	G

Malonyl CoA decarboxylase		E
Malonyl CoA transferase		E
Maltase-glucoamylase		E
Mannosidase, alpha B lysosomal	MANB	E
Marenostrin	MEFV	T
MAX-interacting protein 1	MXI1	G
MEK kinase, MEKK		E
Melanocortin 2 receptor	MC2R	T
Melanocortin 4 receptor	MC4R	T
Menin	MEN1	G
Metallothionein		T
Mevalonate kinase	MVK	E
MHC Class I: A		I
MHC Class I: B		I
MHC Class I: C		I
MHC Class I: LMP-2, LMP-7		I
MHC Class I: Tap1	ABCR, TAP1	I
MHC Class II: DP	HLA-DPB1	I
MHC Class II: DQ		I
MHC Class II: DR		I
MHC Class II: Tap2	TAP2, PSF2	I
MHC Class II: Complementation group A	MHC2TA	I
MHC Class II: Complementation group B	rfxank	I
MHC Class II: Complementation group C	RFX5	I
MHC Class II: Complementation group D	RFXAP	I
Microsomal triglyceride transfer protein	MTP	T
Mitochondrial trifunctional protein, alpha subunit	HADHA	E
Mitochondrial trifunctional protein, beta subunit	HADHB	E
Molybdenum cofactor synthesis 1	MOCS1	E
Molybdenum cofactor synthesis 2	MOCS2	E
Monoamine oxidase A	MAOA	E
Monoamine oxidase B	MAOB	E
Motilin	MLN	G
Msh homeobox homolog 2	MSX2	G
Mucin 18	MUC18	T
Mucin, MUC2		T
Mucin, MUC5AC		T
Mucin, MUC6		T
Mucopolysaccharidoses	GNPTA	E
Mulibrey nanism	MUL	T
Muscarinic receptor, M1	CHRM1	N
Muscarinic receptor, M2	CHRM2	N
Muscarinic receptor, M3	CHRM3	N
Muscarinic receptor, M4	CHRM4	N
Muscarinic receptor, M5	CHRM5	N
Muscle phosphorylase	PYGM	E
Mutated in colorectal cancers, MCC	MCC	G

MutL homolog 1	MLH1	G
MutS homolog 2	MSH2	G
MutS homolog 3	MSH3	G
Myoglobin		T
Myosin 15	MYO15	S
Myosin 5A	MYO5A	S
Myosin 6	MYO6	S
Myosin 7A	MYO7A	S
Myosin, cardiac	MYH7	S
Myosin, light chain 2	MYL2	S
Myosin, light chain 3	MYL3	S
Myotubularin	MTM1	S
Na <sup>+</sup> , K <sup>+</sup> ATPase, alpha	ATP1A1	G
Na <sup>+</sup> , K <sup>+</sup> ATPase, beta 1	ATP1B1	G
Na <sup>+</sup> , K <sup>+</sup> ATPase, beta 2	ATP1B2	G
Na <sup>+</sup> , K <sup>+</sup> ATPase, beta 3	ATP1B3	G
Na <sup>+</sup> /H <sup>+</sup> exchanger 1	NHE1	T
Na <sup>+</sup> /H <sup>+</sup> exchanger 2	NHE2	T
Na <sup>+</sup> /H <sup>+</sup> exchanger 3	NHE3	T
Na <sup>+</sup> /H <sup>+</sup> exchanger 4	NHE4	T
Na <sup>+</sup> /H <sup>+</sup> exchanger 5	NHE5	T
Na <sup>+</sup> -coupled glucose/galactose transporter		T
N-acetylgalactosamine-6-sulfate sulfatase	GALNS	E
N-acetylglucosamine-6-sulfatase	GNS	E
N-acetylglucosaminidase, alpha	NAGLU	E
NADH dehydrogenase		E
NADH dehydrogenase (ubiquinone) Fe-S protein 1	NDUFS1	E
NADH dehydrogenase (ubiquinone) Fe-S protein 4	NDUFS4	E
NADH dehydrogenase (ubiquinone) flavoprotein 1	NDUFV1	E
NADH-cytochrome b5 reductase	DIA1	E
NADPH-dependent cytochrome P450 reductase	POR	E
NB6		I
Nephrolithiasis 2	NPHL2	T
Nephronophthisis 1	NPHP1	T
Nephronophthisis 2	NPHP2	T
Nephrosis 1	NPHS1	T
Nerve growth factor	NGF	G
Nerve growth factor receptor	NGFR	G
Neuraminidase sialidase	NEU	T
Neurofibromin 1	NF1	G
Neurofibromin 2	NF2	G
Neurokinin A	NKNA	N
Neurokinin B	NKNB	N
Neurotensin	NTS	N

Neurotensin receptor	NTSR1	N
Notch ligand - jagged 1	JAG1, AGS	G
Nuclear factor I-kappa-B-like gene	IKBL	I
Oncogene ERB		G
Oncogene ERB2		G
Oncogene ERBA		G
Oncogene ERBAL2		G
Oncogene GLI1	GLI	G
Oncogene GLI2	GLI2	G
Oncogene GLI3	GLI3	G
Oncogene met	MET	G
Oncogene myb	MYB	G
Oncogene myc	MYC	G
Oncogene n-myc		G
Oncogene ret	RET	G
Oncogene r-myc		G
Oncogene sis	PDGFB	G
Oncogene spi1		G
Oncogene src		G
Oncogene v-Ki-ras2	KRAS2	G
Orexin	OX	G
Orexin 1 receptor	OX1R	G
Orexin 2 receptor	OX2R	G
Ornithine transcarbamoylase	OTC, NME1	E
Osteopontin	OPN	G
Paired box homeotic gene 2	PAX2	G
Paired box homeotic gene 3	PAX3	G
Paired box homeotic gene 6	PAX6	G
Paired box homeotic gene 8	PAX8	G
Palmitoyl-protein thioesterase	PPT	T
Pancreatic amylase		E
Pancreatic colipase		T
Pancreatic lipase	PNLIP	E
Pancreatic lipase related protein 1	PLRP1	E
Pancreatic lipase related protein 2	PLRP2	E
Paraoxonase PON1	PON1	E
Paraoxonase PON2	PON2	E
Paraoxonase PON3		E
Parathyroid hormone	PTH	G
Parathyroid hormone receptor	PTHrP	G
Parathyroid hormone related-peptide	PTHrP	G
Parathyroid hormone-like hormone	PTHLH	G
Parvalbumin	PVALB	G
Patched (Drosophila) homolog, PTCH	PTCH	G
Pepsin		T
Pepsinogen		E
Peptidases A		T
Peptidases B		T

Peptidases C		T
Peptidases D	PEPD	T
Peptidases E		T
Peptidases S		T
Peroxidase, salivary	SAPX	E
Peroxisomal membrane protein 1	PXMP1	S
Peroxisomal membrane protein 3	PXMP3	T
Peroxisome biogenesis factor 1	PEX1	T
Peroxisome biogenesis factor 19	PEX19	T
Peroxisome biogenesis factor 6	PEX6	T
Peroxisome biogenesis factor 7	PEX7	T
Peroxisome receptor 1	PXR1	T
Phenylalanine monooxygenase		E
Phosphatase & tensin homolog	PTEN	G
Phosphate regulating gene with homologies to endopeptidases on the X chromosome	PHEX	G
Phosphoenolpyruvate carboxykinase	PCK1	E
Phosphofructokinase, liver	PFKL	E
Phosphofructokinase, muscle	PFKM	E
Phosphoglucomutase		E
Phosphoglucose isomerase	GPI	E
Phosphoglycerate kinase 1	PGK1	E
Phosphoglycerate mutase 2	PGAM2	E
Phospholipase A2, group 10	PLA2G10	I
Phospholipase A2, group 1B	PLA2G1B	I
Phospholipase A2, group 2A	PLA2G2A	I
Phospholipase A2, group 2B	PLA2G2B	I
Phospholipase A2, group 4A	PLA2G4A	I
Phospholipase A2, group 4C	PLA2G4C	I
Phospholipase A2, group 5	PLA2G5	I
Phospholipase A2, group 6	PLA2G6	I
Phospholipase C alpha		I
Phospholipase C beta		I
Phospholipase C delta	PLCD1	I
Phospholipase C epsilon		I
Phospholipase C gamma	PLCG1	I
Phosphomannomutase 2	PMM2	G
Phosphomannomutase-2	PMM2	T
Phosphomannose isomerase-1, PMI1	MPI	T
Phosphoribosyl pyrophosphate synthetase	PRPS1	E
Phosphorylase kinase deficiency, liver	PHK	E
Phosphorylase kinase, alpha 1 (muscle)	PHKA1	E
Phosphorylase kinase, alpha 2	PHKA2	E
Phosphorylase kinase, beta	PHKB	E
Phosphorylase kinase, delta		E
Phosphorylase kinase, gamma 2	PHKG2	E
Plasminogen	PLG	E
Plasminogen activator inhibitor 1	PAI1	E

Plasminogen activator inhibitor 2	PAI2	E
Plasminogen activator receptor, Urokinase	UPAR; PLAUR	S
Plasminogen activator, Tissue	PLAT; TPA	E
Plasminogen activator, Urokinase	UPA; PLAU	E
Platelet derived growth factor	PDGF	G
Platelet derived growth factor receptor	PDGFR	G
Platelet monamine oxidase		T
Platelet-activating factor receptor	PAFR	I
Polycystic kidney and hepatic disease 1	PKHD1	T
Polycystin 1	PKD1	T
Polycystin 2	PKD2	T
Polymorphonuclear elastase		T
Potassium inwardly-rectifying channel J1	KCNJ1	N
Potassium inwardly-rectifying channel J11	KCNJ11	N
Potassium voltage-gated channel E1	KCNE1	N
Prekallikrein		I
Preproenkephalin	PENK	N
Preproglucagon	GCG;GLP1; GLP2	G
Preproglucagon		T
Preproinsulin		T
Procollagen N-protease		E
Proline dehydrogenase	PRODH	E
Proline-rich protein BstNI subfamily 1	PRB1	S
Proline-rich protein BstNI subfamily 3	PRB3	S
Proline-rich protein BstNI subfamily 4	PRB4	S
Prolyl-4-hydroxylase		E
Pro-melanin-concentrating hormone	PMCH	G
Proopiomelanocortin	POMC	N
Prosaposin	PSAP	N
Prostacyclin synthase		I
Prostaglandin 15-OH dehydrogenase	HGPD; PGDH	I
Prostaglandin D - DP receptor		I
Prostaglandin E1 receptor		I
Prostaglandin E2 receptor		I
Prostaglandin E3 receptor		I
Prostaglandin F - FP receptor		I
Prostaglandin F2 alpha receptor		I
Prostaglandin I2 receptor		T
Prostaglandin IP receptor		I
Protease inhibitor 1		T
Protective protein for beta-galactosidase	PPGB	E
Protein C	PROC	I
Protein C inhibitor	PCI	I
Protein kinase B	PRKB	
Protein S	PROS1	I
Protein tyrosine phosphatase, non-receptor type 12	PTPN12	G
Prothrombin precursor	F2	I

Pterin-4-alpha-carbinolamine	PCBD	
Pyruvate carboxylase	PC	E
Pyruvate decarboxylase	PDHA	E
Pyruvate kinase	PKLR	E
Quinoid dihydropteridine reductase	QDPR	E
Renal glutaminase		T
Renin	REN	E
Replication factor C	RFC2	E
Retinoblastoma 1	RB1	G
Retinol binding protein 1		T
Retinol binding protein 2		T
Retinoschisis, X-linked, juvenile	RS	G
RIGUI	RIGUI	G
SA homolog	SAH	G
Salivary amylase, AMY1		T
SAP (SLAM-associated protein)	SH2D1A	I
Secretin	SCT	T
Secretin receptor, SCTR	SCTR	T
Serotonin receptor, 5HT1A	HTR1A	N
Serotonin receptor, 5HT1B	HTR1B	N
Serotonin receptor, 5HT1C	HTR1C	N
Serotonin receptor, 5HT1D	HTR1D	N
Serotonin receptor, 5HT1E	HTR1E	N
Serotonin receptor, 5HT1F	HTR1F	N
Serotonin receptor, 5HT2A	HTR2A	N
Serotonin receptor, 5HT2B	HTR2B	N
Serotonin receptor, 5HT2C	HTR2C	N
Serotonin receptor, 5HT3	HTR3	N
Serotonin receptor, 5HT4	HTR4	N
Serotonin receptor, 5HT5	HTR5	N
Serotonin receptor, 5HT6	HTR6	N
Serotonin receptor, 5HT7	HTR7	N
Sodium channel, non-voltage gated 1, alpha	SCNN1A	N
Sodium channel, non-voltage gated 1, beta	SCNN1B	N
Sodium channel, non-voltage gated 1, gamma	SCNN1G	N
Sodium channel, voltage-gated, type 1, beta	SCN1B	N
polypeptide		
Solute carrier family 10 (sodium/bile acid cotransporter family), member 1	SLC10A1	T
Solute carrier family 10 (sodium/bile acid cotransporter family), member 2	SLC10A2	T
Solute carrier family 12, member 1	SLC12A1	T
Solute carrier family 12, member 2	SLC12A2	T
Solute carrier family 12, member 3	SLC12A3	T
Solute carrier family 14, member 2	SLC14A2	T
Solute carrier family 15 (H <sup>+</sup> /peptide transporter, intestinal), member 1	SLC15A1	T
Solute carrier family 15 (H <sup>+</sup> /peptide	SLC15A2	T



transporter, kidney), member 2		
Solute carrier family 16 (monocarboxylate transporter), member 1	SLC16A1	T
Solute carrier family 16 (monocarboxylate transporter), member 7	SLC16A7	T
Solute carrier family 17, member 1	SLC17A1	T
Solute carrier family 17, member 2	SLC17A2	T
Solute carrier family 2 (facilitated glucose transporter), member 1	SLC2A1	T
Solute carrier family 2 (facilitated glucose transporter), member 2	SLC2A2	T
Solute carrier family 2 (facilitated glucose transporter), member 3	SLC2A3	T
Solute carrier family 2 (facilitated glucose transporter), member 4	SLC2A4	T
Solute carrier family 2 (facilitated glucose transporter), member 5	SLC2A5	T
Solute carrier family 21, member 2	SLC21A2	T
Solute carrier family 21, member 3	SLC21A3	T
Solute carrier family 22, member 1	SLC22A1	T
Solute carrier family 22, member 2	SLC22A2	T
Solute carrier family 22, member 5	SLC22A5	T
Solute carrier family 3 (facilitated glucose transporter), member 1	SLC3A1	T
Solute carrier family 4 (anion exchanger), member 1	SLC4A1	T
Solute carrier family 4 (anion exchanger), member 2	SLC4A2	T
Solute carrier family 4 (anion exchanger), member 3	SLC4A3	T
Solute carrier family 5 (sodium/glucose transporter), member 1	SLC5A1	T
Solute carrier family 5 (sodium/glucose transporter), member 2	SLC5A2	T
Solute carrier family 5 (sodium/glucose transporter), member 5	SLC5A5	T
Solute carrier family 5, member 3	SLC5A3	T
Solute carrier family 6 (GAMMA-AMINOBUTYRIC ACID transporter), member 1	SLC6A1	T
Solute carrier family 6 (neurotransmitter transporter, dopamine), member 3	SLC6A3	T
Solute carrier family 6 (neurotransmitter transporter, noradrenaline), member 2	SLC6A2	T
Solute carrier family 6, member 6	SLC6A6	T
Solute carrier family 7(amino acid transporter), member 1	SLC7A1	T
Solute carrier family 7(amino acid transporter), member 2	SLC7A2	T

Solute carrier family 7(amino acid transporter), member 7	SLC7A7	T
Somatostatin	SST	N
Somatostatin receptor, SSTR1	SSTR1	N
Somatostatin receptor, SSTR2	SSTR2	G
Somatostatin receptor, SSTR3	SSTR3	N
Somatostatin receptor, SSTR4	SSTR4	N
Somatostatin receptor, SSTR5	SSTR5	N
Sphingomyelinase	SMPD1	E
Steroid 5 alpha reductase 1	SRD5A1	E
Steroid 5 alpha reductase 2	SRD5A2	E
Sterol carrier protein 2	SCP2	T
Substance P		N
Succinyl CoA synthase		E
Sucrase		E
Sucrase-isomaltase	SI	T
Superoxide dismutase 1	SOD1	E
Surfeit 1	SURF1	G
Talin	TLN	G
Talin, TLN		S
TATA binding protein	TBP	G
T-BOX 1	TBX1	G
T-BOX 2	TBX2	G
T-BOX 3	TBX3	G
Thiolase, peroxisomal		E
Thrombin receptor	F2R	I
Thrombopoietin	THPO	G
Thromboxane A synthase 1	TBXAS1	I
Tip-associated protein	TAP	I
Topoisomerase I		E
Torticollis, keloids, cryptorchidism and renal dysplasia gene	TKCR	G
Transacylase		E
Transcobalamin 1, TCN1		T
Transcobalamin 2, TCN2	TCN2	T
Transcription factor 1, hepatic	TCF1	G
Transcription factor 2, hepatic	TCF2	G
Transferrin	TF	G
Transferrin receptor	TFRC	G
Transforming growth factor, beta 2	TGFB2	G
Transforming growth factor, beta induced	TGFBI	G
Transforming growth factor, beta receptor 2	TGFBR2	G
Transglutaminase 4	TGM4	G
Transketolase	TKT	E
Transketolase-like 1	TKTL1	E
Translocation in renal carcinoma on chromosome 8 gene	TRC8	G
Transthyretin	TTR	T

Trehalase		T
Triosephosphate isomerase	TPI1	E
Trypsin inhibitor		E
Trypsinogen 1	TRY1	E
Trypsinogen 2	TRY2	E
Trypsinogen activation peptide		T
Tuberous sclerosis 1	TSC1	G
Tuberous sclerosis 2	TSC2	G
Tumour necrosis factor (TNF) receptor associated factor 1	TRAF1	I
Tumour necrosis factor (TNF) receptor associated factor 2	TRAF2	I
Tumour necrosis factor (TNF) receptor associated factor 3	TRAF3	I
Tumour necrosis factor (TNF) receptor associated factor 4	TRAF4	I
Tumour necrosis factor (TNF) receptor associated factor 5	TRAF5	I
Tumour necrosis factor (TNF) receptor associated factor 6	TRAF6	I
Tumour necrosis factor alpha	TNFA	I
Tumour necrosis factor alpha receptor	TNFAR	I
Tumour necrosis factor beta	TNFB	I
Tumour necrosis factor beta receptor	TNFBR	I
Tumour protein p53	TP53, P53	G
Tumour protein p63	TP63	G
Tumour suppressor gene DRA	DRA	I
Tyrosinase	TYR	E
UDP-glucose pyrophosphorylase		E
UDP-glucuronosyltransferase 1	ugt1d, UGT1	E
UDP-glucuronosyltransferase 2	UGT2	E
Uridinediphosphate(UDP)-galactose-4-epimerase	GALE	E
Uroporphyrinogen decarboxylase	UROD	E
Uroporphyrinogen III synthase	UROS	E
Vasoactive intestinal polypeptide	VIP	N
Vasoactive intestinal polypeptide receptor	VIPR	N
Vasoinhibitory peptide		G
Villin		S
Von Hippel-Lindau gene	VHL	G
Von Willebrand factor	VWF	T
Wiskott-Aldrich syndrome protein	WASP, THC	I
Wolf-Hirschhorn syndrome candidate 1 gene	WHSC1	G
Wolfram syndrome 1 gene	WFS1	S
Xanthine dehydrogenase	XDH	E
Xeroderma pigmentosum, complementation group A	XPA	E
Xeroderma pigmentosum, complementation group B	XPB	E

group B		
Xeroderma pigmentosum, complementation	XPC	E
group C		
Xeroderma pigmentosum, complementation		E
group D		
Xeroderma pigmentosum, complementation		E
group E		
Xeroderma pigmentosum, complementation	XPF	E
group F		
Xeroderma pigmentosum, complementation	ERCC5	E
group G		
Zinc finger protein 3	ZIC3	S

In a tenth aspect.

## RESPIRATORY SYSTEM

The present invention relates to a method of assessing the risk of developing clinical or social consequences following dysfunction, damage or disease of the respiratory system and indicating appropriate therapeutic interventions.

The human body has an absolute requirement for oxygen in order to carry out the basic metabolic processes required for survival. The portal of entry for oxygen is the respiratory system (mouth, nose, trachea, bronchi, bronchioles, alveoli and the vascular elements which transport oxygen, pulmonary arteries, veins, capillaries and lymphatic tissues). The respiratory system is required to work 24 hours a day for a lifetime. Despite the exposure of the respiratory system to pollution and airborne pathogens the systems capacity for defence and repair enables it to ward off pathology and continue normal function. However, excessive pollution or a compromised defence system will lead to damage and disease. For example, smoking which is now known to damage lung function leading to infection and tumourigenesis, and defects such as cystic fibrosis where mutations in lung proteins lead to a compromise in function and susceptibility to infections.

The major functions of the respiratory system include:

- Pumping gases into and out of the body.
- Gas exchange (oxygen into the body and carbon dioxide out of the body).
- Matching oxygen supply to bodily requirements.

These functional requirements place considerable demands on the structural organisation of the lungs. In order to facilitate gas exchange the surface area of air /blood contact must be as large as possible (the surface area of the lungs is almost the size of a tennis court, Weatherall, Ledingham and Warrell 1996). In addition, the tissue barrier between air and blood must be as thin as possible. These requirements lead directly to the specialised structures seen the tissues of the respiratory system.

The specialised tissues mediating air/blood contact (alveoli) need to be supported during the pumping movements of the lung and this is achieved by the presence of the peripheral fibre system which encases the tissues (in close aposition to blood vessels) from the hilum to the visceral pleura. The tissues which make up the gas exchange surface in the alveoli must be capable of allowing blood access to the oxygen and of defending and repairing themselves when damaged by airborne contaminants or pathogens. The alveoli are composed of three layers of cells, the epithelium (lining the air spaces composed of type I and type II - secretory cells), an interstitial layer housing the connective tissue and an endothelium lining the capillaries. In addition there are alveolar macrophages which represent a core feature of the tissue defence system. One of the important aspects of type II cell function is the secretion of surfactants (primarily DPPC – dipalmitoylphosphatidylcholine with a number of apoproteins SP-A, SP-B, SP-C)) which act to reduce the surface tension at the air water interface and prevent the surfaces of the alveoli sticking to each other. The control of surfactant synthesis and its removal are tightly regulated (by neurohumoral

pathways and vagal stimulation). The control of surfactant production is particularly important in the foetus during lung development.

Alveolar macrophages are present within the liquid layer of surfactant. These cells act as the first line of defence in order to intercept and remove unwanted or foreign materials on the surface of the lungs. They co-operate in their defence activity with interstitial macrophages, histiocytes, leucocytes, and mast cells.

In situations where alveolar cell activity cannot cope with environmental damage (e.g. inhalation of toxic fumes, massive blood loss) the epithelium can become damaged beyond its capacity to repair and so the alveoli become oedematous leading to a loss of the gas exchange function. This situation requires intensive medical management and in many cases will lead to permanent loss of lung functionality. The situation can be exacerbated if there is a significant inflammatory reaction within the lung tissues (e.g. chronic bronchitis, emphysema, asthma, lung transplant rejection etc.).

The lung has a series of 'housekeeping' processes which are essential in order to maintain its normal function (Weatherall, Leadingham and Warrell 1996):

- Surfactant synthesis and release in order to promote and maintain a low surface tension in alveoli.
- Clearance of particulate matter and identification of potential pathological inflammatory reactions and pathogens.
- Regulation of smooth muscle tone in vascular walls and lung tissues.
- Clearance of fluids to prevent oedema.
- Regulation of hormones in the pulmonary capillary endothelium.

Failure to maintain normal housekeeping functions can lead to a wide variety of conditions such as chronic obstructive pulmonary disease, asthma, diffuse interstitial fibrosis, alveolar filling, adult respiratory distress syndrome, pulmonary vascular disease. Such housekeeping functions are also readily compromised by the presence of tumours within the respiratory system.

The effect of dysfunction, damage or disease in the respiratory system will often manifest itself as cough (a defensive reflex designed to clear the lower respiratory tract), breathlessness (this symptom ranges from shortness of breath following exercise to severe breathing problems whilst lying in bed) and chest pain (only the upper respiratory tract and parietal pleura are sensitive to pain). Further detailed examination of the patient including an assessment of other physical signs (e.g. abnormalities in shape of chest wall, cyanosis, clubbing of fingers, eczema, urticaria, sarcoidosis, tuberous sclerosis, abnormalities in the cardiovascular system or swelling in the lymphatic system) and imaging studies in order to identify specific syndromes or diseases.

The clinical spectrum of the dysfunction, damage and disease of the respiratory system is broad and includes:

Allergic rhinitis ('hay fever').

Airway obstruction (e.g. tumours, foreign body).

Asthma.  
Cystic fibrosis.  
Bronchiectasis.  
Chronic obstructive pulmonary disease.  
Diffuse parenchymal lung disease.  
Cryptogenic fibrosing alveolitis.  
Pulmonary vasculitis.  
Pulmonary haemorrhagic disorders.  
Allergic alveolitis.  
Sarcoidosis.  
Toxin induced damage.  
Pleural disease.  
Scoliosis.  
Neoplasia.  
Sleep related apnoea's  
Upper respiratory tract infections (e.g. Coxsackie A, echovirus, influenza, coronavirus, mycoplasma, staphylococcus).  
Lower respiratory tract infections (e.g. respiratory syncytial virus, influenza, measles, rhinovirus, pneumococcus, legionella, mycoplasma, tuberculosis).

Some groups of patients such as those with AIDS, or undergoing immunosuppression therapy following transplants or chemotherapy are particularly susceptible to infections of the respiratory system. Pulmonary involvement can also be prominent in systemic collagen-vascular diseases (e.g. rheumatoid arthritis, systemic lupus erythromatosus, ankylosing spondylitis).

Therapeutic approaches to dysfunction, damage and disease of the respiratory system include, antibiotics, antiviral agents, cytotoxic chemotherapy (for lung tumours), anti-inflammatory therapies (for asthma) and approaches to gene therapy (for inherited disorders such as cystic fibrosis). In addition surgical approaches such as resection or transplantation dramatically improve the chances of survival of patients with disorders such as lung cancer and pulmonary hypertension (although the issue of tissue rejection remains a problem). In cases where surgery or transplantation is inappropriate (e.g. deep coma following head injury, in patients with respiratory failure due to muscular or skeletal disorders or in patients undergoing chest surgery) machine assisted ventilation has made significant progress.

However, many of these drugs also have side-effects such as sedation, orthostatic hypertension, sexual dysfunction, reflex tachycardia and impaired cognition (Brody, Larner and Minneman 1998, British National Formulary 1998). As a result of the side effects and the disordered mental state of many patients compliance in drug therapy is a significant issue in healthcare management. Such problems can be greatly magnified when dealing with patients with a personality disorder.

The physiology and control of the body's respiratory system is extremely complex and involves the synergistic or inhibitory interaction between multiple regulatory pathways and molecular cascades. Variation in the functionality of the proteins involved in these processes will, inevitably, cause or have an impact on the

functioning of these systems or an individuals attempts to minimise damage and restore function following dysfunction, damage or disease in these systems. A number of constitutional factors are known to impact on the individuals ability to deal with and recover from clinical or social consequences following dysfunction, damage or disease of the respiratory system including genetic history, age, sex, nutritional status, pre-existing disease or injury, drug treatments and socio-economic circumstances. Genetic variation within individuals is also a key factor although the extent and nature of the genes involved and their precise impact on prognosis, complications, efficacy of therapeutic intervention and eventual recovery of function is largely unknown.

The individual variability in response to the occurrence of dysfunction, damage or disease of the respiratory system and the associated variation in symptomatology, response to therapy and adverse events resulting from therapeutic interventions lies at the heart of the difficulties experienced in the healthcare and social management of respiratory system dysfunction, damage and disease.

We have elaborated on the value and utility to be derived from the gathering together of the genes which form the core gene list for this particular Genostic system.

These genes are elaborated below:

#### KEY TO 'PROTEIN FUNCTION' COLUMN

E ENZYME  
T TRANSPORT & STORAGE  
S STRUCTURAL  
I IMMUNITY  
N NERVOUS TRANSMISSION  
G GROWTH & DIFFERENTIATION

RESPIRATORY GENE LIST	HUGO gene symbol	Protein function
11beta hydroxysteroid dehydrogenase 2	HSD11B2	E
2,3-bisphosphoglycerate mutase	BPGM	E
3 beta hydroxysteroid dehydrogenase 2	HSD3B2	E
Acetoacetyl 1-CoA-thiolase	ACAT1	E
Acetoacetyl 2-CoA-thiolase	ACAT2	E
Acetyl CoA synthase		E
Acetylcholine receptor, nicotinic, gamma	CHRNA7	N
Acetylcholinesterase	ACHE	E
Aconitase		E
Acyl CoA dehydrogenase, long chain	ACADL	E
Acyl CoA dehydrogenase, medium chain	ACADM	E
Acyl CoA dehydrogenase, short chain	ACADS	E
Acyl CoA dehydrogenase, very long chain	ACADVL	E
Adaptin, beta 3A	ADTB3A	T
Adenosine deaminase	ADA	E
Adenosine receptor A1	ADORA1	N



Adenosine receptor A2A	ADORA2A	N
Adenosine receptor A2B	ADORA2B	N
Adenosine receptor A3	ADORA3	N
Adenylate cyclase 1	ADCY1	E
Adenylate cyclase 2	ADCY2	E
Adenylate cyclase 3	ADCY3	E
Adenylate cyclase 4	ADCY4	E
Adenylate cyclase 5	ADCY5	E
Adenylate cyclase 6	ADCY6	E
Adenylate cyclase 7	ADCY7	E
Adenylate cyclase 8	ADCY8	E
Adenylate cyclase 9	ADCY9	E
Adrenergic receptor, alpha1	ADRA1	N
Adrenergic receptor, alpha2	ADRA2	N
Adrenergic receptor, beta1	ADRB1	N
Adrenergic receptor, beta2	ADRB2	N
Adrenergic receptor, beta3	ADRB3	N
Adrenocorticotrophic hormone (ACTH) receptor	ACTHR	G
Albumin, ALB	ALB	T
Alcohol dehydrogenase 1	ADH1	E
Alcohol dehydrogenase 2	ADH2	E
Alcohol dehydrogenase 3	ADH3	E
Alcohol dehydrogenase 4	ADH4	E
Alcohol dehydrogenase 5	ADH5	E
Alcohol dehydrogenase 6	ADH6	E
Alcohol dehydrogenase 7	ADH7	E
Aldolase A	ALDOA	E
Aldolase B	ALDOB	E
Aldolase C	ALDOC	E
Aldosterone receptor	MLR	G
Alpha 2 macroglobulin	A2M	I
alpha1-antichymotrypsin	AACT	E
alpha1-antitrypsin	PI	E
alpha2-antiplasmin	PLI	E
alpha-actinin 2	ACTN2	G
alpha-actinin 3	ACTN3	G
alpha-Galactosidase A	GLA	E
alpha-ketoglutarate dehydrogenase		E
Aminopeptidase P	XPNPEP2	E
Amphiregulin	AREG	G
Androgen receptor	AR	G
Angiopoietin 1	ANGPT1	G
Angiopoietin 2	ANGPT2	G
Angiotensin converting enzyme	ACE, DCP1	E
Angiotensin receptor 1	AGTR1	T
Angiotensin receptor 2	AGTR2	T
Angiotensinogen	AGT	E

Annexin 1	ANX 1	I
Antidiuretic hormone receptor	ADHR	T
Antithrombin III	AT3	E
Apolipoprotein E	APOE	T
Arginase	ARG1	E
Arginine vasopressin	AVP	N
Arginine vasopressin receptor 1A	AVPR1A	N
Arginine vasopressin receptor 1B	AVPR1B	N
Arginine vasopressin receptor 2	AVPR2	N
Arginosuccinate lyase	ASL	E
Arylsulfatase D	ARSD	E
Arylsulfatase E	ARSE	E
Arylsulfatase F	ARSF	E
Aspartate transaminase		T
Ataxia telangiectasia gene, A $\tau$	ATM	G
ATP/ADP translocase		E
Atrial natriuretic peptide	ANP	G
Atrial natriuretic peptide receptor A	NPR1	G
Atrial natriuretic peptide receptor B	NPR2	G
Atrial natriuretic peptide receptor C	NPR3	G
beta-galactosidase	GLB1	E
beta-Glucuronidase	GUSB	E
Biotinidase	BTB	E
Bloom syndrome protein	BLM	G
Bradykinin receptor B1		I
Bradykinin receptor B2		I
Butyrylcholinesterase	BCHE	E
C1 inhibitor		E
Cadherin E	CDH1	G
Cadherin EP		G
Cadherin N	CDH2	G
Cadherin P	CDH3	G
Calcitonin receptor /Calcitonin gene-related peptide receptor	CALCR	N
Calcitonin/Calcitonin gene-related peptide alpha	CALCA	N
Calcium channel, voltage-dependent, alpha 1F subunit	CACNA1F	N
Calcium channel, voltage-dependent, Alpha-1B (CACNL1A5)	CACNA1B	N
Calcium channel, voltage-dependent, Alpha-1C	CACNA1C	N
Calcium channel, voltage-dependent, Alpha-1D	CACNA1D	N
Calcium channel, voltage-dependent, Alpha-1E (CACNL1A6)	CACNA1E	N
Calcium channel, voltage-dependent, Alpha-2/delta	CACNA2	N

Calcium channel, voltage-dependent, Beta 1	CACNB1	N
Calcium channel, voltage-dependent, Beta 3	CACNB3	N
Calcium channel, voltage-dependent, Neuronal, Gamma	CACNG2	N
Calcium channel, voltage-dependent, T-type		N
Calmodulin 1	CALM1	G
Calmodulin 2	CALM2	G
Calmodulin 3	CALM3	G
Calnexin	CANX	G
Carbonic anhydrase 3	CA3	E
Carbonic anhydrase 4	CA4	E
Carbonic anhydrase, alpha	CA1	E
Carbonic anhydrase, beta	CA2	E
Carnitine acetyltransferase	CRAT	E
Carnitine acylcarnitine translocase	CACT	E
Catalase	CAT	I
Cathepsin B		E
Cathepsin D		E
Cathepsin E		E
Cathepsin G	CTSG	E
Cathepsin H		E
Cathepsin K	CTSK	E
Cathepsin L		E
Cathepsin S		E
CD1	CD1	I
CD4	CD4	I
Cell adhesion molecule, intercellular, ICAM	ICAM1	G
Cell adhesion molecule, leukocyte-endothelial, LECAM (CD62)	LECAM1	G
Cell adhesion molecule, liver, LCAM	LCAM	G
Cell adhesion molecule, neural, NCAM1	NCAM1	G
Cell adhesion molecule, neural, NCAM120	NCAM120	G
Cell adhesion molecule, neural, NCAM2	NCAM2	G
Cell adhesion molecule, platelet-endothelial, PECAM	PECAM1	G
Cell adhesion molecule, vascular, VCAM	VCAM1	G
Chemokine receptor CXCR4	CXCR4	I
Chitotriosidase	chit	E
Cholecystokinin	CCK	N
Cholecystokinin B receptor	CCKBR	N
Choline acetyltransferase	CHAT	E
Citrate synthase		E
Coenzyme Q (CoQ)/ubiquinone		E
Collagen I alpha 1	COL1A1	S
Collagen I alpha 2	COL1A2	S
Collagen II alpha 1	COL2A1	S
Collagen III alpha 1	COL3A1	S
Collagen IV alpha 1	COL4A1	S

Collagen IV alpha 2	COL4A2	S
Collagen IV alpha 3	COL4A3	S
Collagen IV alpha 4	COL4A4	S
Collagen IV alpha 5	COL4A5	S
Collagen IV alpha 6	COL4A6	S
Collagen IX alpha 2	COL9A2, EDM2	S
Collagen IX alpha 3	COL9A3	S
Collagen receptor	COLR	S
Collagen V alpha 1	COL5A1	S
Collagen V alpha 2	COL5A2	S
Collagen VI alpha 1	COL6A1	S
Collagen VI alpha 2	COL6A2	S
Collagen VI alpha 3	COL6A3	S
Collagen VII alpha 1	COL7A1	S
Collagen X alpha 1	COL10A1	S
Collagen X alpha 1	COL11A1	S
Collagen XI alpha 2	COL11A2	S
Collagen XVII alpha 1	COL17A1	S
Colony-stimulating factor 1	CSF1	G
Colony-stimulating factor 1 receptor	CSF1R	G
Colony-stimulating factor 2	CSF2	G
Colony-stimulating factor 2 alpha receptor	CSF2RA	G
Colony-stimulating factor 2 beta receptor	CSF2RB	G
Colony-stimulating factor 3	CSF3	G
Colony-stimulating factor 3 receptor	CSF3R	G
Complement component C1 inhibitor	C1NH	I
Complement component C1qa	C1QA	I
Complement component C1qb	C1QB	I
Complement component C1qg	C1QG	I
Complement component C1r	C1R	I
Complement component C1s	C1S	I
Complement component C2	C2	I
Complement component C3	C3	I
Complement component C4A	C4A	I
Complement component C4B	C4B	I
Complement component C5	C5	I
Complement component C6	C6	I
Complement component C7	C7	I
Complement component C8	C8B	I
Complement component C9	C9	I
Complement component receptor 1	CR1	I
Complement component receptor 2	CR2	I
Complement component receptor 3	CR3	I
Complex I		E
Complex II		E
Complex III		E
Complex III		E
Complex V	MTATP6	E

Coproporphyrinogen oxidase	CPO	E
Corticotrophin-releasing hormone	CRH	T
Corticotrophin-releasing hormone receptor	CRHR1	T
Cortisol receptor		I
C-reactive protein CRP		I
Creatine kinase – B and m	CKBE	E
Creb binding protein	CREBBP	G
Cu <sup>2+</sup> transporting ATPase alpha polypeptide	ATP7A	E
Cyclic AMP-dependent protein kinase	PKA	E
Cyclic nucleotide phosphodiesterase 1B	PDE1B	E
Cyclic nucleotide phosphodiesterase 1B1	PDE1B1	E
Cyclic nucleotide phosphodiesterase 2A3	PDE2A3	E
Cyclic nucleotide phosphodiesterase 3A	PDE3A	E
Cyclic nucleotide phosphodiesterase 3B	PDE3B	E
Cyclic nucleotide phosphodiesterase 4A	PDE4A	E
Cyclic nucleotide phosphodiesterase 4C	PDE4C	E
Cyclic nucleotide phosphodiesterase 5A	PDE5A	E
Cyclic nucleotide phosphodiesterase 6A	PDE6A	E
Cyclic nucleotide phosphodiesterase 6B	PDE6B	E
Cyclic nucleotide phosphodiesterase 7	PDE7	E
Cyclic nucleotide phosphodiesterase 8	PDE8	E
Cyclic nucleotide phosphodiesterase 9A	PDE9A	E
Cyclin-dependent kinase 2	CDK2	G
Cyclin-dependent kinase inhibitor 2A (p16)	CDKN2A	G
Cyclooxygenase 1	COX1	E
Cyclooxygenase 2	COX2	E
CYP11A1	CYP11A1	E
CYP11B1	CYP11B1	E
CYP11B2	CYP11B2	E
CYP17	CYP17	E
CYP19	CYP19	E
CYP1A1	CYP1A1	E
CYP1A2	CYP1A2	E
CYP1B1	CYP1B1	E
CYP21	CYP21	E
CYP24	CYP24	E
CYP27	CYP27	E
CYP27B1	PDDR	E
CYP2A1	CYP2A1	E
CYP2A13	CYP2A13	E
CYP2A3	CYP2A3	E
CYP2A6V2	CYP2A6V2	E
CYP2A7	CYP2A7	E
CYP2B6	CYP2B6	E
CYP2C18	CYP2C18	E
CYP2C19	CYP2C19	E
CYP2C8	CYP2C8	E
CYP2C9	CYP2C9	E

CYP2D6	CYP2D6	E
CYP2E1	CYP2E1	E
CYP2F1	CYP2F1	E
CYP2J2	CYP2J2	E
CYP3A3	CYP3A3	E
CYP3A4	CYP3A4	E
CYP3A5	CYP3A5	E
CYP3A7	CYP3A7	E
CYP4A11	CYP4A11	E
CYP4B1	CYP4B1	E
CYP4F2	CYP4F2	E
CYP4F3	CYP4F3	E
CYP51	CYP51	E
CYP5A1	CYP5A1	E
CYP7A	CYP7A	E
CYP8	CYP8	E
Cystathionase	CTH	E
Cystathione beta synthase	CBS	E
Cystic fibrosis transmembrane conductance regulator, CFTR	CFTR	N
Cytidine deaminase	CDA	E
Cytidine-5-prime-triphosphate synthetase	CTPS	E
Cytochrome a		E
Cytochrome b-245 alpha	CYBA	E
Cytochrome b-245 beta	CYBB	E
Cytochrome b-5	CYB5	E
Cytochrome c		E
Cytochrome c oxidase, MTCO		E
Cytokine-suppressive antiinflammatory drug- binding protein 1	CSBP1	I
Cytokine-suppressive antiinflammatory drug- binding protein 2	CSBP2	I
DAX1 nuclear receptor	DAX1	I
D-beta-hydroxybutyrate dehydrogenase		E
Delta 4-5 alpha-reductase		E
Desmin	DES	S
Dihydrolipoamide dehydrogenase	DLD	N
DNA glycosylases		E
Dopamine beta hydroxylase	DBH	E
Dopamine receptors D1	DRD1	N
Dopamine receptors D2	DRD2	N
Dopamine receptors D3	DRD3	N
Dopamine receptors D4	DRD4	N
Dopamine receptors D5	DRD5	N
Dystrophin	DMD	S
Elastase 1	ELAS1	E
Elastase 2	ELAS2	E
Elastin	ELN	S

Electron-transferring-flavoprotein alpha	ETFA	T
Electron-transferring-flavoprotein beta	ETFB	T
Electron-transferring flavoprotein dehydrogenase	ETFDH	E
Endothelin 1	EDN1	N
Endothelin 2	EDN2	N
Endothelin 3	EDN3	N
Endothelin converting enzyme	ECE1	N
Endothelin receptor type A	EDNRA	N
Endothelin receptor type B	EDNRB	N
Enolase	ENO1	E
Enoyl CoA hydratase		E
Enoyl CoA isomerase		E
Enoyl CoA reductase		E
Enterokinase	PRSS7, ENTK	E
Ephrin receptor tyrosine kinase A	EPHA	G
Ephrin receptor tyrosine kinase B	EPHB	G
Epidermal growth factor	EGF	G
Epidermal growth factor receptor	EGFR	G
Epoxide hydrolase 1, microsomal	EPHX1	E
Estrogen receptor	ESR	G
EWS RNA-binding protein	EWSR1	G
Eyes absent 1	EYA1	G
Faciogenital dysplasia	FGD1, FGDY	T
Factor 1 (No. one)	F1	I
Factor B, properdin		I
Factor D		I
Factor H	HF1	I
Factor I (letter I)	IF	I
Factor III	F3	I
Factor IX	F9	I
Factor V	F5	I
Factor VII	F7	I
Factor VIII	F8	I
Factor X	F10	I
Factor XI	F11	I
Factor XII	F12	I
Factor XIII A & B	F13A & F13B	I
Fc fragment of IgG, high affinity IA, receptor for	FCGR1A	G
Fc fragment of IgG, low affinity IIa, receptor for (CD32)	FCGR2A	G
Fc fragment of IgG, low affinity IIIa, receptor for (CD16)	FCGR3A	G
Fibrillin 1	FBN1	G
Fibrinogen alpha	FGA	S
Fibrinogen beta	FGB	S
Fibrinogen gamma	FGG	S

Fibroblast growth factor	FGF1	G
Fibroblast growth factor receptor 1	FGFR1	G
Fibroblast growth factor receptor 2	FGFR2	G
Fibroblast growth factor receptor 3	FGFR3	G
Fibronectin precursor	FN1	G
Flightless-II, Drosophila homolog of	FLII	G
Follicle stimulating hormone receptor	FSHR, ODG1	G
Follicle stimulating hormone, FSH	FSHB	G
Forkhead rhabdomyosarcoma gene	FKHR	G
Fructose-1,6-diphosphatase	FBP1	E
Furin		T
GABA receptor, alpha 1	GABRA1	N
GABA receptor, alpha 2	GABRA2	N
GABA receptor, alpha 3	GABRA3	N
GABA receptor, alpha 4	GABRA4	N
GABA receptor, alpha 5	GABRA5	N
GABA receptor, alpha 6	GABRA6	N
GABA receptor, beta 1	GABRB1	N
GABA receptor, beta 2	GABRB2	N
GABA receptor, beta 3	GABRB3	N
GABA receptor, gamma 1	GABRG1	N
GABA receptor, gamma 2	GABRG2	N
GABA receptor, gamma 3	GABRG3	N
GABA transaminase	ABAT	E
Galactocerebrosidase	GALC	E
Galactosyltransferase 1	GT1	G
Galactosyltransferase, alpha 1,3	GGTA1	G
Galactosyltransferase, beta 3	B3GALT	G
Glucocorticoid receptor	GRL	G
Glucokinase	GCK	E
Glucosidase, acid alpha	GAA	E
Glutamate dehydrogenase	GLUD1	E
Glutamate receptor 1	GLUR1	N
Glutamate receptor 2	GLUR2	N
Glutamate receptor 3	GLUR3	N
Glutamate receptor 4	GLUR4	N
Glutamate receptor 5	GLUR5	N
Glutamate receptor 6	GLUR6	N
Glutamate receptor 7	GLUR7	N
Glutamate receptor, ionotropic, NMDA 1	NMDAR1	N
Glutamate receptor, ionotropic, NMDA 2A	NMDAR2A	N
Glutamate receptor, ionotropic, NMDA 2B	NMDAR2B	N
Glutamate receptor, ionotropic, NMDA 2C	NMDAR2C	N
Glutamate receptor, ionotropic, NMDA 2D	NMDAR2D	N
Glutathione	GSH	T
Glutathione peroxidase, GPX1	GPX1	E
Glutathione peroxidase, GPX2	GPX2	E
Glutathione reductase, GSR	GSR	E



Glutathione S-transferase mu 1, GSTM1	GSTM1	E
Glutathione S-transferase mu 4, GSTM4		E
Glutathione S-transferase theta 1, GSTT1	GSTT1	E
Glutathione S-transferase theta 2, GSTT2		E
Glutathione S-transferase, GSTP1	GSTP1	E
Glutathione S-transferase, GSTZ1	GSTZ1	E
Glutathione synthetase	GSS	E
Glyceraldehyde-3-phosphate dehydrogenase, GAPDH	GAPDH	E
Glycerol kinase	GK	E
Glycinamide ribonucleotide (GAR) transformylase	GART	E
GM2 ganglioside activator protein, GM2A	GM2A	E
Growth arrest-specific homeobox	GAX	G
Guanylyl cyclase		E
Haemoglobin alpha 1	HBA1	T
Haemoglobin alpha 2	HBA2	T
Haemoglobin beta	HBB	T
Haemoglobin delta	HBD	T
Haemoglobin gamma A	HBG1	T
Haemoglobin gamma B	HBG2	T
Haemoglobin gamma G	HBGG	T
Heat shock protein, HSP60		I
Heat shock protein, HSP70		I
Heat shock protein, HSP90		I
Heat shock protein, HSPA1		I
Heat shock protein, HSPA2		I
Heparin binding epidermal growth factor	HBEGF	G
Heparin Cofactor II	HCF2	I
Hermansky-pudlak syndrome gene	HPS	T
Hexokinase 1	HK1	E
Hexokinase 2	HK2	E
Hexosaminidase A	HEXA,TSD	E
Histamine receptors, H1		N
Histamine receptors, H2		N
Histamine receptors, H3		N
HMG-CoA lyase	HMGCL	E
HMG-CoA reductase	HMGCR	E
HMG-CoA synthase	HMGCS2	E
Holocarboxylase synthetase	HLCS	E
Hyaluronidase		T
Hypoxia inducible factor 1	HIF1A	E
Hypoxia inducible factor 2		E
Immunoglobulin E (IgE) responsiveness gene	IGER	I
Immunoglobulin E (IgE) serum concentration regulator gene	IGES	I
Immunoglobulin gamma (IgG) 2	IGHG2	I
Insulin	INS	G

Insulin receptor	INSR	G
Insulin-like growth factor 1	IGF1	G
Insulin-like growth factor 1 receptor	IGF1R	G
Insulin-like growth factor 2	IGF2	G
Insulin-like growth factor 2 receptor	IGF2R	G
Integrin beta 1	ITGB1	G
Integrin beta 2	ITGB2	G
Integrin beta 5	ITGB5	G
Integrin beta 6	ITGB6	G
Integrin, alpha M	ITGAM	G
Inter-alpha-trypsin inhibitor, IATi		E
Interferon alpha	IFNA1	I
Interferon beta	IFNB	I
Interferon gamma	IFNG	I
Interferon gamma receptor 1	IFNGR1	I
Interferon gamma receptor 2	IFNGR2	I
Interferon regulatory factor 1	IRF1	I
Interferon regulatory factor 4	IRF4	I
Interleukin(IL) 1 receptor	IL1R	I
Interleukin(IL) 1, alpha	IL1A	I
Interleukin(IL) 1, beta	IL1B	I
Interleukin(IL) 10	IL10	I
Interleukin(IL) 10 receptor	IL10R	I
Interleukin(IL) 11	IL11	I
Interleukin(IL) 11 receptor	IL11R	I
Interleukin(IL) 12	IL12	I
Interleukin(IL) 12 receptor, beta 1	IL12RB1	I
Interleukin(IL) 13	IL13	I
Interleukin(IL) 13 receptor	IL13R	I
Interleukin(IL) 2	IL2	I
Interleukin(IL) 2 receptor, alpha	IL2RA	I
Interleukin(IL) 2 receptor, gamma	IL2RG	I
Interleukin(IL) 3	IL3	I
Interleukin(IL) 3 receptor	IL3R	I
Interleukin(IL) 4	IL4	I
Interleukin(IL) 4 receptor	IL4R	I
Interleukin(IL) 5	IL5	I
Interleukin(IL) 5 receptor	IL5R	I
Interleukin(IL) 6	IL6	I
Interleukin(IL) 6 receptor	IL6R	I
Interleukin(IL) 7	IL7	I
Interleukin(IL) 7 receptor	IL7R	I
Interleukin(IL) 8	IL8	I
Interleukin(IL) 8 receptor	IL8R	I
Interleukin(IL) 9	IL9	I
Interleukin(IL) 9 receptor	IL9R	I
Interleukin(IL) receptor antagonist 1	IL1RN, IL1RA	I
Isocitrate dehydrogenase		E

Kallikrein 3	KAK3	I
Kininogen, High molecular weight	KNG	I
Kynureninease		E
Laminin 5, alpha 3	LAMA3	G
Laminin 5, beta 3	LAMB3	G
Laminin 5, gamma 2	LAMC2	G
Laminin M	LAMM	G
Laminin receptor 1	LAMR1	G
Latent transforming growth factor-beta binding protein 2	LTBP2	G
Lecithin-cholesterol acyltransferase	LCAT	E
Leptin	LEP	G
Leptin receptor	LEPR	G
Leukotriene A4 hydrolase		I
Leukotriene A4 synthase	LTA4S	E
Leukotriene B4 receptor		I
Leukotriene B4 synthase	LTB4S	E
Leukotriene C4 receptor		I
Leukotriene C4 synthase	LTC4S	E
Leukotriene D4/E4 receptor		I
LIM homeobox protein 1	LHX1	G
Lipoamide dehydrogenase	OGDH	E
Lipoprotein lipase	LPL	I
Lipoprotein receptor, Low Density	LDLR	T
Lipoprotein, High Density	HDLDT1	T
Lipoprotein, Intermediate Density		T
Lipoprotein, Low Density 1		T
Lipoprotein, Low Density 2		T
Lipoprotein, Very Low Density	VLDLR	T
Lipoxygenase		E
Low density lipoprotein receptor-related protein precursor	LRP	T
Lymphoid enhancer-binding factor	LEF-1	G
Lysosomal acid lipase	LIPA	E
Lysozyme	LYZ	I
MAD (mothers against decapentaplegic, Drosophila) homologue 4	MADH4	G
Malate dehydrogenase, mitochondrial	MDH2	E
Malonyl CoA transferase		E
Mannose binding protein	MBP	I
Mannosidase, alpha B lysosomal	MANB	E
Mannosidase, beta A lysosomal	MANBA	E
Matrix Gla protein	MGP	G
Matrix metalloproteinase 1	MMP1	E
Matrix metalloproteinase 10	MMP10	E
Matrix metalloproteinase 11	MMP11	E
Matrix metalloproteinase 12	MMP12	E
Matrix metalloproteinase 13	MMP13	E

Matrix metalloproteinase 14	MMP14	E
Matrix metalloproteinase 15	MMP15	E
Matrix metalloproteinase 16	MMP16	E
Matrix metalloproteinase 17	MMP17	E
Matrix metalloproteinase 18	MMP18	E
Matrix metalloproteinase 19	MMP19	E
Matrix metalloproteinase 2	MMP2	E
Matrix metalloproteinase 3	MMP3, STMY1	E
Matrix metalloproteinase 4	MMP4	E
Matrix metalloproteinase 5	MMP5	E
Matrix metalloproteinase 6	MMP6	E
Matrix metalloproteinase 7	MMP7	E
Matrix metalloproteinase 8	MMP8	E
Matrix metalloproteinase 9	MMP9	E
Methionine adenosyltransferase	MAT1A, MAT2A	E
Midline 1	MID1	G
Mitochondrial trifunctional protein, alpha subunit	HADHA	E
Mitochondrial trifunctional protein, beta subunit	HADHB	E
Monoamine oxidase A	MAOA	E
Monoamine oxidase B	MAOB	E
Muscarinic receptor, M1	CHRM1	N
Muscarinic receptor, M2	CHRM2	N
Muscarinic receptor, M3	CHRM3	N
Muscarinic receptor, M4	CHRM4	N
Muscarinic receptor, M5	CHRM5	N
Myoglobin		T
Myotubularin	MTM1	S
Na <sup>+</sup> , K <sup>+</sup> ATPase, alpha	ATP1A1	G
Na <sup>+</sup> , K <sup>+</sup> ATPase, beta 1	ATP1B1	G
Na <sup>+</sup> , K <sup>+</sup> ATPase, beta 2	ATP1B2	G
Na <sup>+</sup> , K <sup>+</sup> ATPase, beta 3	ATP1B3	G
NADH dehydrogenase		E
NADH dehydrogenase (ubiquinone) Fe-S protein 1	NDUFS1	E
NADH dehydrogenase (ubiquinone) Fe-S protein 4	NDUFS4	E
NADH dehydrogenase (ubiquinone) flavoprotein 1	NDUFV1	E
NADH-cytochrome b5 reductase	DIA1	E
NADPH-dependent cytochrome P450 reductase	POR	E
Nebulin	NEB	S
Nephrosis 1	NPHS1	T
Nerve growth factor	NGF	G
Nerve growth factor receptor	NGFR	G
Neuraminidase sialidase	NEU	T

Neuregulin	HGL	G
Neurofibromin 1	NF1	G
Neurofibromin 2	NF2	G
Neurokinin A	NKNA	N
Neurokinin B	NKNB	N
Neuropeptide Y	NPY	N
Neuropeptide Y receptor Y1	NPY1R	N
Neuropeptide Y receptor Y2	NPY2R	N
Nitric oxide synthase 1, NOS1	NOS1	E
Nitric oxide synthase 2, NOS2	NOS2	E
Nitric oxide synthase 3, NOS3	NOS3	E
Notch ligand - jagged 1	JAG1, AGS	G
Nucleoside diphosphate kinase-A	NDPKA	E
Oncogene ELK1	ELK1	G
Oncogene ELK2	ELK2	G
Oncogene sis	PDGFB	G
Ornithine delta-aminotransferase	OAT	E
Paired box homeotic gene 6	PAX6	G
Parathyroid hormone	PTH	G
Parathyroid hormone receptor	PTHR1	G
Parathyroid hormone related-peptide	PTHrP	G
Parathyroid hormone-like hormone	PTHLH	G
Patched (Drosophila) homolog, PTCH	PTCH	G
Peroxisomal membrane protein 3	PXMP3	T
Peroxisome biogenesis factor 1	PEX1	T
Peroxisome biogenesis factor 19	PEX19	T
Peroxisome biogenesis factor 6	PEX6	T
Peroxisome biogenesis factor 7	PEX7	T
Peroxisome receptor 1	PXR1	T
Phenylalanine hydroxylase	PAH	E
Phenylalanine monooxygenase		E
Phenylethanolamine N-methyltransferase, PNMT	PNMT	E
Phosphofructokinase, liver	PFKL	E
Phosphofructokinase, muscle	PFKM	E
Phosphoglucomutase		E
Phosphoglucose isomerase	GPI	E
Phosphoglycerate kinase 1	PGK1	E
Phosphoglycerate mutase 2	PGAM2	E
Phospholipase A2, group 10	PLA2G10	I
Phospholipase A2, group 1B	PLA2G1B	I
Phospholipase A2, group 2A	PLA2G2A	I
Phospholipase A2, group 2B	PLA2G2B	I
Phospholipase A2, group 4A	PLA2G4A	I
Phospholipase A2, group 4C	PLA2G4C	I
Phospholipase A2, group 5	PLA2G5	I
Phospholipase A2, group 6	PLA2G6	I
Phospholipase C epsilon		I

Pineolytic beta-receptors		E
Plasminogen	PLG	E
Plasminogen activator inhibitor 1	PAI1	E
Plasminogen activator inhibitor 2	PAI2	E
Plasminogen activator receptor, Urokinase	UPAR; PLAUR	S
Plasminogen activator, Tissue	PLAT; TPA	E
Plasminogen activator, Urokinase	UPA; PLAU	E
Platelet derived growth factor	PDGF	G
Platelet derived growth factor receptor	PDGFR	G
Platelet-activating factor receptor	PAFR	I
Potassium inwardly-rectifying channel J1	KCNJ1	N
Potassium voltage-gated channel E1	KCNE1	N
Prekallikrein		I
Procollagen N-protease		E
Progesterone receptor (RU486 binding receptor)	PGR	G
Proliferin	PLF	G
Proopiomelanocortin	POMC	N
Properdin P factor, complement	PFC, PFD	I
Prosaposin	PSAP	N
Prostacyclin synthase		I
Prostaglandin 15-OH dehydrogenase	HGPD; PGDH	I
Prostaglandin D - DP receptor		I
Prostaglandin E1 receptor		I
Prostaglandin E2 receptor		I
Prostaglandin E3 receptor		I
Prostaglandin F - FP receptor		I
Prostaglandin F2 alpha receptor		I
Prostaglandin I2 receptor		T
Prostaglandin IP receptor		I
Protein C	PROC	I
Protein C inhibitor	PCI	I
Protein phosphatase 2, regulatory subunit A, beta isoform	PPP2R1B	E
Protein S	PROS1	I
Prothrombin precursor	F2	I
Pyruvate carboxylase	PC	E
Pyruvate decarboxylase	PDHA	E
Pyruvate kinase	PKLR	E
Quinoid dihydropteridine reductase	QDPR	E
Renin	REN	E
Replication factor C	RFC2	E
Retinoblastoma 1	RB1	G
RIGUI	RIGUI	G
Salivary amylase, AMY1		T
Selectin E	SELE	N
Selectin L	SELL	N
Selectin P	SELP	N

Serine hydroxymethyltransferase	SHMT	E
Serotonin receptor, 5HT1A	HTR1A	N
Serotonin receptor, 5HT1B	HTR1B	N
Serotonin receptor, 5HT1C	HTR1C	N
Serotonin receptor, 5HT1D	HTR1D	N
Serotonin receptor, 5HT1E	HTR1E	N
Serotonin receptor, 5HT1F	HTR1F	N
Serotonin receptor, 5HT2A	HTR2A	N
Serotonin receptor, 5HT2B	HTR2B	N
Serotonin receptor, 5HT2C	HTR2C	N
Serotonin receptor, 5HT3	HTR3	N
Serotonin receptor, 5HT4	HTR4	N
Serotonin receptor, 5HT5	HTR5	N
Serotonin receptor, 5HT6	HTR6	N
Serotonin receptor, 5HT7	HTR7	N
Sodium channel, non-voltage gated 1, alpha	SCNN1A	N
Sodium channel, non-voltage gated 1, beta	SCNN1B	N
Sodium channel, non-voltage gated 1, gamma	SCNN1G	N
Sodium channel, voltage gated, type IV, alpha polypeptide	SCN4A	N
Sodium channel, voltage-gated, type 1, beta polypeptide	SCN1B	N
Solute carrier family 21, member 2	SLC21A2	T
Solute carrier family 4 (anion exchanger), member 1	SLC4A1	T
Solute carrier family 4 (anion exchanger), member 2	SLC4A2	T
Solute carrier family 4 (anion exchanger), member 3	SLC4A3	T
Solute carrier family 6 (GAMMA-AMINOBTYRIC ACID transporter), member 1	SLC6A1	T
Solute carrier family 6 (neurotransmitter transporter, dopamine), member 3	SLC6A3	T
Solute carrier family 6 (neurotransmitter transporter, noradrenaline), member 2	SLC6A2	T
Somatostatin receptor, SSTR2	SSTR2	G
Sphingomyelinase	SMPD1	E
Substance P		N
Succinate dehydrogenase 2	SDH2	E
Succinate thiokinase		E
Succinyl CoA synthase		E
Superoxide dismutase 1	SOD1	E
Superoxide dismutase 3	SOD3	E
Surfactant pulmonary-associated protein A1	SFTPA1	T
Surfactant pulmonary-associated protein A2	SFTPA2	T
Surfactant pulmonary-associated protein B	SFTPB	T

Surfactant pulmonary-associated protein C	SFTPC	T
Surfactant pulmonary-associated protein D	SFTPD	T
Surfeit 1	SURF1	G
Survival of motor neuron 1, telomeric	SMN1	T
Talin	TLN	G
T-BOX 2	TBX2	G
T-BOX 3	TBX3	G
TEK, tyrosine kinase, endothelial	TEK	E
Telomerase protein component		E
Thiolase, peroxisomal		E
Thrombin receptor	F2R	I
Thrombomodulin	THBD	I
Thrombopoietin	THPO	G
Thrombospondin	THBS1	G
Thromboxane A synthase 1	TBXAS1	I
Thromboxane A2	TXA2	I
Thromboxane A2 receptor	TBXA2R	I
Thyroglobulin	TG	G
Thyroid hormone receptor, alpha	THRA	G
Thyroid hormone receptor, beta	THRB	G
Thyroid peroxidase	TPO	G
Thyroid receptor auxiliary protein	TRAP	G
Thyroid-stimulating hormone receptor	TSHR	G
Thyroid-stimulating hormone, alpha	TSHA	G
Thyroid-stimulating hormone, beta	TSHB	G
Thyrotropin releasing hormone receptor	TRHR	G
Topoisomerase I		E
Transacylase		E
Transferrin	TF	G
Transferrin receptor	TFRC	G
Transforming growth factor, beta 2	TGFB2	G
Transforming growth factor, beta induced	TGFB1	G
Transforming growth factor, beta receptor 2	TGFBR2	G
Transketolase	TKT	E
Transketolase-like 1	TKTL1	E
Triosephosphate isomerase	TPI1	E
Trypsin inhibitor		E
Uncoupling protein 1		T
Uroporphyrinogen III synthase	UROS	E
Vasoactive intestinal polypeptide receptor	VIPR	N
Vasoinhibitory peptide		G
Vitronectin receptor, alpha	VNRA	T
Von Hippel-Lindau gene	VHL	G
Wolf-Hirschhorn syndrome candidate 1 gene	WHSC1	G
Xanthine dehydrogenase	XDH	E



In a eleventh aspect.

## INJURY, INFLAMMATION, IMMUNITY AND INFECTION PATENT APPLICATION

The present invention relates to a method of assessing the risk of developing the clinical or social consequences of injury, inflammation, immunity and/or repair and indicating appropriate therapeutic interventions.

Infection and injury are the commonest causes of death in humans under the age of fifty. In a simplistic way both injury and infection can be regarded as events which compromise and destroy the integrity and functionality of tissues, thus leading to debilitating physical states. The human body has evolved a series of physiological responses in order to contain and repair the consequences of injury and infection. These responses are described in the concepts of inflammation, immunity and repair.

Humans are continually exposed to pathogens every minute of the day in the external environment, yet considering the degree of exposure clinical infections are uncommon and death from infection is a relatively rare event. Whilst there is an increasing body of knowledge concerning the genomic structure and physiology of pathogens there is still substantial ignorance concerning the pathophysiology and variability in the individual response to potential pathogens and infection (Weatherall, Leadingham and Warrell et al 1996).

The skin, mucosa and epithelia (e.g. of the gut or urinary tract) provide important physical and biochemical barriers to potential pathogens. Secretion of bactericidal substances (e.g. lysozyme) increase the value of the barrier. As a result damage or injury to the skin surface or to the epithelia lining the gut wall or nasal passages can lead to increased susceptibility to infection.

Association, adhesion and invasion are the key features which characterise the ability of infectious agents to interact with body tissues.

Association – describes the interaction of pathogens with proteins of the cellular surface or cellular matrix (e.g. CD4 receptor, fibronectin, laminin, collagen).

Adhesion – describes the process whereby pathogen ligands bind to cell surface receptors (usually a glycoprotein or glycolipid e.g. C3 receptor).

Invasion – describes the process (similar to phagocytosis for bacteria) whereby a pathogen is able to cross the cellular wall and invade the cytoplasm or sub-cellular compartments or nucleus of a cell and disrupt cellular function.

Many pathogens such as bacteria produce toxins which have a deleterious effect on cellular functioning. Such toxins can be categorised as either endotoxins (e.g. lipid A of Gram-negative bacteria) which are released when the cellular structure of the micro-organism is disrupted or exotoxins which are proteinaceous toxins secreted by the pathogen (such as the Shiga toxin of *S. dysenteriae*).

Toxins damage host tissues in a variety of ways, such as the overproduction of inflammatory cytokines (IL-1 and 6 and tumour necrosis factor  $\alpha$  by lipid A) or the ADP-ribosylation of G-proteins causing severe dysfunction of membrane enzymes such as adenylate cyclase (by cholera toxin and pertussis toxin).

The destruction of body tissues by injury, pathogens or the release of toxins can lead to a series of physiological changes including, fever, increased basal metabolic rate, increased cardiac output, and changes in plasma proteins. Together these changes have been termed the acute phase reaction and the orchestration of this reaction is achieved by cytokine release from cells of the macrophage/monocyte lineage. Although the symptoms of the acute phase response are unpleasant for the patient there is evidence that they can have a beneficial effect (e.g. the pronounced effect of fever on neurosyphilitic infections, inhibition of bacterial growth by acute phase proteins). However, it is also well documented that an extended acute phase reaction can evolve into a syndrome of septic shock in which excess production of tumour necrosis factor  $\alpha$  induces detrimental phenomena such as vascular damage resulting in a fatal clinical condition.

Following the generalised physiological response to pathogens specific cell are recruited to the site of the infection or injury. Polymorphic neutrophil leucocytes are generally the first to be involved in attempts to neutralise pathogens. They are attracted to the relevant sites by chemotactic factors on the pathogens or by complement activation following antibody labelling. Pathogens thus identified are then destroyed by phagocytosis.

The complement pathway is a central feature of the protective immune response. The pathway is a complex cascade of proteins which serve to attract white cells to the site of infection and pathogen, facilitate the process of phagocytosis and have a direct effect on pathogens by disrupting their cell walls. The pathway is activated by the presence of immune complexes ('classical' complement pathway), by the presence of microbial products ('alternative' complement pathway) or as a consequence of the digestion of complement component by bacterial proteases. People with deficiencies in proteins which make up the complement cascade are known to have an increased vulnerability to infection.

Specific defences against particular pathogens are the result of the generation of specific antibodies by B and T lymphocytes due to priming by a previous infection or vaccination or to the *de-novo* recognition of pathogen molecules.

Immune system mediated destruction of pathogens is the result of the synergistic action between antibodies and polymorphic neutrophil leukocytes. Destruction of pathogens sheltering within host cells is mediated by sensitised T lymphocytes engaging in direct cytolytic action. Direct contact between effector and target cell is required and the cells must share the same class I histocompatibility antigens. Sensitised lymphocytes can also modulate macrophage activity by secreting lymphokines.

restore function. A number of constitutional factors are known to impact on the individuals ability to deal with and recover from infection and injury including age, sex, nutritional status, pre-existing disease or injury and drug treatments. Genetic variation within individuals is also a key factor although the extent and nature of the genes involved and their precise impact on prognosis, complications, efficacy of therapeutic intervention and eventual recovery of function is largely unknown.

The individual variability in response to injury and infection and the associated variation in symptomatology, response to therapy and adverse events resulting from therapeutic interventions lies at the heart of the difficulties experienced in the healthcare and social management of injury and infection.

We have elaborated on the value and utility to be derived from the gathering together of the genes which form the core gene list for this particular Genostic system.

These genes are elaborated below:

#### KEY TO 'PROTEIN FUNCTION' COLUMN

E ENZYME  
T TRANSPORT & STORAGE  
S STRUCTURAL  
I IMMUNITY  
N NERVOUS TRANSMISSION  
G GROWTH & DIFFERENTIATION

IMMUNITY GENE LIST	HUGO gene symbol	Protein function
5,10-methylenetetrahydrofolate reductase (NADPH)	MTHFR	E
Acetylcholinesterase	ACHE	E
Acidic amino acid transporter		T
Actin, alpha, cardiac	ACTC	S
Actin, alpha, skeletal	ACTA1	S
Actin, alpha, smooth, aortic	ACTA2	S
Actin, beta	ACTB	S
Actin, gamma 2	ACTG2	S
ADAM (A disintegrin and metalloproteinase) 1	ADAM1	E
ADAM (A disintegrin and metalloproteinase) 10	ADAM10	E
ADAM (A disintegrin and metalloproteinase) 11	ADAM11	E
ADAM (A disintegrin and metalloproteinase) 12	ADAM12	E
ADAM (A disintegrin and metalloproteinase) 13	ADAM13	E
ADAM (A disintegrin and metalloproteinase) 14	ADAM14	E
ADAM (A disintegrin and metalloproteinase) 15	ADAM15	E
ADAM (A disintegrin and metalloproteinase) 16	ADAM16	E
ADAM (A disintegrin and metalloproteinase) 17	ADAM17	E
ADAM (A disintegrin and metalloproteinase) 18	ADAM18	E
ADAM (A disintegrin and metalloproteinase) 19	ADAM19	E

ADAM (A disintegrin and metalloproteinase) 2	ADAM2	E
ADAM (A disintegrin and metalloproteinase) 3A	ADAM3A	E
ADAM (A disintegrin and metalloproteinase) 3B	ADAM3B	E
ADAM (A disintegrin and metalloproteinase) 4	ADAM4	E
ADAM (A disintegrin and metalloproteinase) 5	ADAM5	E
ADAM (A disintegrin and metalloproteinase) 6	ADAM6	E
ADAM (A disintegrin and metalloproteinase) 7	ADAM7	E
ADAM (A disintegrin and metalloproteinase) 8	ADAM8	E
ADAM (A disintegrin and metalloproteinase) 9	ADAM9	E
Adducin, alpha	ADD1	S
Adducin, beta	ADD2	S
Adenosine deaminase	ADA	E
Adenosine receptor A1	ADORA1	N
Adenosine receptor A2A	ADORA2A	N
Adenosine receptor A2B	ADORA2B	N
Adenosine receptor A3	ADORA3	N
Adenylate cyclase 1	ADCY1	E
Adenylate cyclase 2	ADCY2	E
Adenylate cyclase 3	ADCY3	E
Adenylate cyclase 4	ADCY4	E
Adenylate cyclase 5	ADCY5	E
Adenylate cyclase 6	ADCY6	E
Adenylate cyclase 7	ADCY7	E
Adenylate cyclase 8	ADCY8	E
Adenylate cyclase 9	ADCY9	E
Adrenergic receptor, alpha1	ADRA1	N
Adrenergic receptor, alpha2	ADRA2	N
Adrenergic receptor, beta1	ADRB1	N
Adrenergic receptor, beta2	ADRB2	N
Adrenergic receptor, beta3	ADRB3	N
Adrenocorticotrophic hormone (ACTH) receptor	ACTHR	G
Albumin, ALB	ALB	T
Aldosterone receptor	MLR	G
Alpha 1 acid glycoprotein	AAG; AGP	T
Alpha 2 macroglobulin	A2M	I
alpha1-antitrypsin	PI	E
alpha2-antiplasmin	PLI	E
Alpha-fetoprotein	AFP	G
alpha-glucosidase, neutral AB	GANAB	E
alpha-glucosidase, neutral C	GANC	E
Aminopeptidase P	XPNPEP2	E
Amylo-1,6-glucosidase	AGL	E
Amyloid beta A4 precursor protein	APP	N
Amyloid beta A4 precursor-like protein	APLP	N
Androgen binding protein	ABP	T

Androgen receptor	AR	G
Angiopoietin 1	ANGPT1	G
Angiopoietin 2	ANGPT2	G
Angiotensin converting enzyme	ACE, DCP1	E
Angiotensin receptor 1	AGTR1	T
Angiotensin receptor 2	AGTR2	T
Angiotensinogen	AGT	E
Annexin 1	ANX 1	I
Antidiuretic hormone receptor	ADHR	T
Anti-Mullerian hormone	AMH	G
Antithrombin III	AT3	E
Apaf-1		S
Apolipoprotein E	APOE	T
Apoptosis antigen 1	APT1	I
Apoptosis antigen ligand 1	APT1LG1	I
Apoptosis-inducing factor	AIF	I
Arginosuccinate lyase	ASL	E
Aryl hydrocarbon receptor	AHR	T
Asparagine synthetase	AS	E
Aspartylglucosaminidase	AGA	E
Ataxia telangiectasia complementation group D	ATD, ATDC	G
Ataxia telangiectasia gene, AT	ATM	G
ATP-binding cassette transporter 7	ABC7	I
Attractin		I
Autoimmune regulator, AIRE	AIRE	I
B-cell CLL/lymphoma 1	BCL1	I
B-cell CLL/lymphoma 10	BCL10	I
B-cell CLL/lymphoma 3	BCL3	I
B-cell CLL/lymphoma 4	BCL4	I
B-cell CLL/lymphoma 5	BCL5	I
B-cell CLL/lymphoma 6	BCL6	I
B-cell CLL/lymphoma 7	BCL7	I
B-cell CLL/lymphoma 8	BCL8	I
B-cell CLL/lymphoma 9	BCL9	I
BCL2-associated X protein	BAX	G
BCL2-related protein A1	BCL2A1	G
Beckwith-Wiedemann region 1A	BWR1A	G
beta 2 microglobulin	B2M	I
Bleomycin hydrolase	BLMH	E
Bloom syndrome protein	BLM	G
Bradykinin receptor B1		I
Bradykinin receptor B2		I
Brain derived neurotrophic factor	BDNF	G
Brain derived neurotrophic factor (BDNF) receptor	BDNFR	G
BRCA1-associated RING domain gene 1	BARD1	G
Breakpoint cluster region	BCR	G
Breast cancer 1	BRCA1	G

Breast cancer 2	BRCA2	G
Breast cancer, ductal, 1	BRCD1	G
Breast cancer, ductal, 2	BRCD2	G
Butyrylcholinesterase	BCHE	E
C3 convertase		E
Cadherin E	CDH1	G
Cadherin EP		G
Cadherin N	CDH2	G
Cadherin P	CDH3	G
Calbindin 1	CALB1	G
Calbindin D9K	CALB3	G
Calcineurin A1	CALNA1	I
Calcineurin A2	CALNA2	I
Calcineurin A3	CALNA3	I
Calcineurin B		I
Calcitonin receptor /Calcitonin gene-related peptide receptor	CALCR	N
Calcitonin/Calcitonin gene-related peptide alpha	CALCA	N
Calcium channel, voltage-dependent, alpha 1F subunit	CACNA1F	N
Calcium channel, voltage-dependent, Alpha-1B (CACNL1A5)	CACNA1B	N
Calcium channel, voltage-dependent, Alpha-1C	CACNA1C	N
Calcium channel, voltage-dependent, Alpha-1D	CACNA1D	N
Calcium channel, voltage-dependent, Alpha-1E (CACNL1A6)	CACNA1E	N
Calcium channel, voltage-dependent, Alpha-2/delta	CACNA2	N
Calcium channel, voltage-dependent, Beta 1	CACNB1	N
Calcium channel, voltage-dependent, Beta 3	CACNB3	N
Calcium channel, voltage-dependent, L type, alpha 1S subunit	CACNA1S	N
Calcium channel, voltage-dependent, Neuronal, Gamma	CACNG2	N
Calcium channel, voltage-dependent, P/Q type, alpha 1A subunit	CACNA1A	N
Calcium channel, voltage-dependent, T-type		N
Calmodulin 1	CALM1	G
Calmodulin 2	CALM2	G
Calmodulin 3	CALM3	G
Calmodulin-dependant protein kinase II	CAMK2A	G
Calnexin	CANX	G
Calpain	CAPN, CAPN3	E
Calretinin	CALB2	N
Canalicular multispecific organic anion	CMOAT	T

transporter		
Carbonic anhydrase 3	CA3	E
Carbonic anhydrase 4	CA4	E
Carbonic anhydrase, alpha	CA1	E
Carbonic anhydrase, beta	CA2	E
Carboxylesterase 1	CES1	E
Cardiac-specific homeobox, CSX	CSX	G
Cartilage-hair hypoplasia gene	CHH	N
Caspase 1	CASP1	G
Catalase	CAT	I
Cathepsin G	CTSG	E
CD1	CD1	I
CD10	CD10	I
CD100	CD100	I
CD101	CD101	I
CD103	CD103	I
CD106	CD106	I
CD107	CD107	I
CD108	CD108	I
CD109	CD109	I
CD110	CD110	I
CD111	CD111	I
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Collagen receptor	COLR	S
Collagen V alpha 1	COL5A1	S
Collagen V alpha 2	COL5A2	S
Collagen VI alpha 1	COL6A1	S
Collagen VI alpha 2	COL6A2	S
Collagen VI alpha 3	COL6A3	S
Collagen VII alpha 1	COL7A1	S
Collagen X alpha 1	COL10A1	S
Collagen X alpha 1	COL11A1	S
Collagen XI alpha 2	COL11A2	S
Collagen XVII alpha 1	COL17A1	S
Collagenic-like tail subunit of asymmetric acetylcholinesterase	COLQ	E
Colony-stimulating factor 1	CSF1	G
Colony-stimulating factor 1 receptor	CSF1R	G
Colony-stimulating factor 2	CSF2	G
Colony-stimulating factor 2 alpha receptor	CSF2RA	G
Colony-stimulating factor 2 beta receptor	CSF2RB	G
Colony-stimulating factor 3	CSF3	G
Colony-stimulating factor 3 receptor	CSF3R	G
Complement component C1 inhibitor	C1NH	I
Complement component C1qa	C1QA	I
Complement component C1qb	C1QB	I
Complement component C1qg	C1QG	I
Complement component C1r	C1R	I
Complement component C1s	C1S	I
Complement component C2	C2	I
Complement component C3	C3	I
Complement component C4A	C4A	I
Complement component C4B	C4B	I
Complement component C5	C5	I
Complement component C6	C6	I
Complement component C7	C7	I
Complement component C8	C8B	I
Complement component C9	C9	I
Complement component receptor 1	CR1	I
Complement component receptor 2	CR2	I
Complement component receptor 3	CR3	I
Contactin	CNTN1	G
Core-binding factor, alpha 1	CBFA1	G
Core-binding factor, alpha 2	CBFA2	G
Core-binding factor, beta	CBFB	G
Cortico-steroid binding protein		T
Corticosteroid nuclear receptor		I
Corticotrophin-releasing hormone	CRH	T
Corticotrophin-releasing hormone receptor	CRHR1	T
Cortisol receptor		I
C-reactive protein CRP		I

c-src tyrosine kinase	CSK	G
Cyclic AMP response element binding protein	CREB	G
Cyclic AMP-dependent protein kinase	PKA	E
Cyclic nucleotide phosphodiesterase 1B	PDE1B	E
Cyclic nucleotide phosphodiesterase 1B1	PDE1B1	E
Cyclic nucleotide phosphodiesterase 2A3	PDE2A3	E
Cyclic nucleotide phosphodiesterase 3A	PDE3A	E
Cyclic nucleotide phosphodiesterase 3B	PDE3B	E
Cyclic nucleotide phosphodiesterase 4A	PDE4A	E
Cyclic nucleotide phosphodiesterase 4C	PDE4C	E
Cyclic nucleotide phosphodiesterase 5A	PDE5A	E
Cyclic nucleotide phosphodiesterase 6A	PDE6A	E
Cyclic nucleotide phosphodiesterase 6B	PDE6B	E
Cyclic nucleotide phosphodiesterase 7	PDE7	E
Cyclic nucleotide phosphodiesterase 8	PDE8	E
Cyclic nucleotide phosphodiesterase 9A	PDE9A	E
Cyclin D	CCND1	G
Cyclin-dependent kinase 1	CDK1	G
Cyclin-dependent kinase 10	CDK10	G
Cyclin-dependent kinase 2	CDK2	G
Cyclin-dependent kinase 3	CDK3	G
Cyclin-dependent kinase 4	CDK4	G
Cyclin-dependent kinase 5	CDK5	G
Cyclin-dependent kinase 6	CDK6	G
Cyclin-dependent kinase 7	CDK7	G
Cyclin-dependent kinase 8	CDK8	G
Cyclin-dependent kinase 9	CDK9	G
Cyclin-dependent kinase inhibitor 1A (P21, CIP1)	CDKN1A	G
Cyclin-dependent kinase inhibitor 1B (P27, KIP1)	CDKN1B	G
Cyclin-dependent kinase inhibitor 1C (P57, KIP2)	CDKN1C	G
Cyclin-dependent kinase inhibitor 2A (p16)	CDKN2A	G
Cyclin-dependent kinase inhibitor 3	CDKN3	G
Cyclooxygenase 1	COX1	E
Cyclooxygenase 2	COX2	E
Cyclophilin		I
CYP11A1	CYP11A1	E
CYP11B1	CYP11B1	E
CYP11B2	CYP11B2	E
CYP17	CYP17	E
CYP19	CYP19	E
CYP1A1	CYP1A1	E
CYP1A2	CYP1A2	E
CYP1B1	CYP1B1	E
CYP21	CYP21	E
CYP24	CYP24	E

CYP27	CYP27	E
CYP27B1	PDDR	E
CYP2A1	CYP2A1	E
CYP2A13	CYP2A13	E
CYP2A3	CYP2A3	E
CYP2A6V2	CYP2A6V2	E
CYP2A7	CYP2A7	E
CYP2B6	CYP2B6	E
CYP2C18	CYP2C18	E
CYP2C19	CYP2C19	E
CYP2C8	CYP2C8	E
CYP2C9	CYP2C9	E
CYP2D6	CYP2D6	E
CYP2E1	CYP2E1	E
CYP2F1	CYP2F1	E
CYP2J2	CYP2J2	E
CYP3A3	CYP3A3	E
CYP3A4	CYP3A4	E
CYP3A5	CYP3A5	E
CYP3A7	CYP3A7	E
CYP4A11	CYP4A11	E
CYP4B1	CYP4B1	E
CYP4F2	CYP4F2	E
CYP4F3	CYP4F3	E
CYP51	CYP51	E
CYP5A1	CYP5A1	E
CYP7A	CYP7A	E
CYP8	CYP8	E
Cystathionase	CTH	E
Cystathione beta synthase	CBS	E
Cystic fibrosis transmembrane conductance regulator, CFTR	CFTR	N
Cytidine deaminase	CDA	E
Cytidine-5-prime-triphosphate synthetase	CTPS	E
Cytochrome a		E
Cytochrome c		E
Cytochrome c oxidase, MTCO		E
Cytokine-suppressive antiinflammatory drug- binding protein 1	CSBP1	I
Cytokine-suppressive antiinflammatory drug- binding protein 2	CSBP2	I
Defender against cell death 1	DAD1	G
Deleted in colorectal carcinoma	DCC	G
Deoxycorticosterone (DOC) receptor		E
Deoxycytidine kinase DCK		E
Dihydrolipoyl dehydrogenase 2	PDHA	E
Dihydrolipoyl transacetylase	PDHA	E
Dopamine receptors D1	DRD1	N

Dopamine receptors D2	DRD2	N
Dopamine receptors D3	DRD3	N
Dopamine receptors D4	DRD4	N
Dopamine receptors D5	DRD5	N
Duffy blood group	FY	T
Dynamin	DNM1	G
EB1		G
Elastase 1	ELAS1	E
Elastase 2	ELAS2	E
Endoglin	ENG	S
Endo-P-D-glucuronidase		I
Enolase	ENO1	E
Erythroid kruppel-like factor	EKLF	G
Erythropoietin	EPO	I
Erythropoietin receptor	EPOR	I
Estrogen receptor	ESR	G
EWS RNA-binding protein	EWSR1	G
Factor 1 (No. one)	F1	I
Factor B, properdin		I
Factor D		I
Factor H	HF1	I
Factor I (letter I)	IF	I
Factor III	F3	I
Factor IX	F9	I
Factor V	F5	I
Factor VII	F7	I
Factor VIII	F8	I
Factor X	F10	I
Factor XI	F11	I
Factor XII	F12	I
Factor XIII A & B	F13A & F13B	I
Fanconi anemia, complementation group C	FANCC	T
Fanconi anemia, complementation group D	FANCD	T
Fc fragment of IgG, low affinity IIa, receptor for (CD32)	FCGR2A	G
Fc receptor		I
Fibrinogen alpha	FGA	S
Fibrinogen beta	FGB	S
Fibrinogen gamma	FGG	S
Fibronectin precursor	FN1	G
Follicle stimulating hormone receptor	FSHR, ODG1	G
Follicle stimulating hormone, FSH	FSHB	G
Follicular lymphoma variant translocation 1	FVT1	I
Forkhead rhabdomyosarcoma gene	FKHR	G
Forkhead transcription factor 7	FKHL7	G
Galactosyltransferase 1	GT1	G
Galactosyltransferase, alpha 1,3	GGTA1	G
Galactosyltransferase, beta 3	B3GALT	G

Glial-cell derived neurotrophic factor (GDNF) receptor		N
Glial-cell derived neurotrophic factor, GDNF	GDNF	N
Glucosaminyl (N-acetyl) transferase 2, l-branching enzyme	GCNT2	E
Glutamate receptor 1	GLUR1	N
Glutamate receptor 2	GLUR2	N
Glutamate receptor 3	GLUR3	N
Glutamate receptor 4	GLUR4	N
Glutamate receptor 5	GLUR5	N
Glutamate receptor 6	GLUR6	N
Glutamate receptor 7	GLUR7	N
Glutamate receptor, ionotropic, NMDA 1	NMDAR1	N
Glutamate receptor, ionotropic, NMDA 2A	NMDAR2A	N
Glutamate receptor, ionotropic, NMDA 2B	NMDAR2B	N
Glutamate receptor, ionotropic, NMDA 2C	NMDAR2C	N
Glutamate receptor, ionotropic, NMDA 2D	NMDAR2D	N
Glutamine synthase		E
Glutathione	GSH	T
Glutathione peroxidase, GPX1	GPX1	E
Glutathione peroxidase, GPX2	GPX2	E
Glutathione S-transferase mu 1, GSTM1	GSTM1	E
Glutathione S-transferase mu 4, GSTM4		E
Glutathione S-transferase, GSTZ1	GSTZ1	E
Glyceraldehyde-3-phosphate dehydrogenase, GAPDH	GAPDH	E
Glycerol kinase	GK	E
Glycinamide ribonucleotide (GAR) transformylase	GART	E
Glycophorin A	GYPA	S
Glycophorin B	GYPB	S
Glycophorin C	GYPC	S
Glycosyltransferases, ABO blood group	ABO	E
Glypican 3	GPC3, SDYS	G
Gonadotropin releasing hormone receptor	GNRHR	G
Growth-regulated protein precursor, GRO	GRO	I
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 1, GNAI1	GNAI1	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 2, GNAI2	GNAI2	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 3, GNAI3	GNAI3	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS1	GNAS1	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS2	GNAS2	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS3	GNAS3	N

Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS4	GNAS4	N
Guanine nucleotide-binding protein, q polypeptide	GNAQ	N
H(+), K(+) - ATPase	ATP4B	N
Haemoglobin alpha 1	HBA1	T
Haemoglobin alpha 2	HBA2	T
Haemoglobin beta	HBB	T
Haemoglobin delta	HBD	T
Haemoglobin gamma A	HBG1	T
Haemoglobin gamma B	HBG2	T
Haemoglobin gamma G	HBGG	T
Haptoglobin, alpha 1	HPA1	I
Haptoglobin, alpha 2	HPA2	I
Haptoglobin, beta	HPB	I
Hemochromatosis	HFE	T
Heparin binding epidermal growth factor	HBEGF	G
Heparin Cofactor II	HCF2	I
Hepatitis B virus integration site 1	HVBS1	I
Hepatitis B virus integration site 2	HVBS6	I
High mobility group protein C	HMGIC	G
High mobility group protein Y	HMG1Y	G
Histamine receptors, H1		N
Histamine receptors, H2		N
Histamine receptors, H3		N
Histatin 1		I
Histatin 2		I
Histatin 3	HTN3	I
HLA-B associated transcript 1	BAT1	I
Holocarboxylase synthetase	HLCS	E
Homeobox 11	HOX11	G
Homeobox HB24	HLX1	G
IC7 A and B		I
Ikaros gene	IKAROS	G
Immunoglobulin alpha (IgA)	IGHA	I
Immunoglobulin delta (IgD)	IGHD	I
Immunoglobulin E (IgE) responsiveness gene	IGER	I
Immunoglobulin E (IgE) serum concentration regulator gene	IGES	I
Immunoglobulin epsilon (IgE)	IGHE	I
Immunoglobulin gamma (IgG) 2	IGHG2	I
Immunoglobulin heavy mu chain	IGHM	I
Immunoglobulin J polypeptide	IGJ	I
Immunoglobulin kappa constant region	IGKC	I
Immunoglobulin kappa variable region	IGKV	I
Insulin-like growth factor 1	IGF1	G
Insulin-like growth factor 1 receptor	IGF1R	G
Insulin-like growth factor 2	IGF2	G

Insulin-like growth factor 2 receptor	IGF2R	G
Integrin beta 1	ITGB1	G
Integrin beta 2	ITGB2	G
Integrin beta 3	ITGB3	G
Integrin beta 4	ITGB4	G
Integrin beta 5	ITGB5	G
Integrin beta 6	ITGB6	G
Integrin beta 7	ITGB7	G
Integrin, alpha 1	ITGA1	G
Integrin, alpha 2	ITGA2	G
Integrin, alpha 4	ITGA4	G
Integrin, alpha 5	ITGA5	G
Integrin, alpha 6	ITGA6	G
Integrin, alpha M	ITGAM	G
Intercellular adhesion molecule 1	ICAM1	I
Intercellular adhesion molecule 2	ICAM2	I
Intercellular adhesion molecule 3	ICAM3	I
Interferon alpha	IFNA1	I
Interferon beta	IFNB	I
Interferon gamma	IFNG	I
Interferon gamma receptor 1	IFNGR1	I
Interferon gamma receptor 2	IFNGR2	I
Interferon regulatory factor 1	IRF1	I
Interferon regulatory factor 4	IRF4	I
Interleukin(IL) 1 receptor	IL1R	I
Interleukin(IL) 1, alpha	IL1A	I
Interleukin(IL) 1, beta	IL1B	I
Interleukin(IL) 10	IL10	I
Interleukin(IL) 10 receptor	IL10R	I
Interleukin(IL) 11	IL11	I
Interleukin(IL) 11 receptor	IL11R	I
Interleukin(IL) 12	IL12	I
Interleukin(IL) 12 receptor, beta 1	IL12RB1	I
Interleukin(IL) 13	IL13	I
Interleukin(IL) 13 receptor	IL13R	I
Interleukin(IL) 2	IL2	I
Interleukin(IL) 2 receptor, alpha	IL2RA	I
Interleukin(IL) 2 receptor, gamma	IL2RG	I
Interleukin(IL) 3	IL3	I
Interleukin(IL) 3 receptor	IL3R	I
Interleukin(IL) 4	IL4	I
Interleukin(IL) 4 receptor	IL4R	I
Interleukin(IL) 5	IL5	I
Interleukin(IL) 5 receptor	IL5R	I
Interleukin(IL) 6	IL6	I
Interleukin(IL) 6 receptor	IL6R	I
Interleukin(IL) 7	IL7	I
Interleukin(IL) 7 receptor	IL7R	I



Interleukin(IL) 8	IL8	I
Interleukin(IL) 8 receptor	IL8R	I
Interleukin(IL) 9	IL9	I
Interleukin(IL) 9 receptor	IL9R	I
Interleukin(IL) receptor antagonist 1	IL1RN, IL1RA	I
Janus kinase 1	JAK1	G
Janus kinase 2	JAK2	G
Janus kinase 3	JAK3	G
Kallikrein 3	KAK3	I
Kell blood group precursor	XK, KEL	T
Kininogen, High molecular weight	KNG	I
Kynureninease		E
Lactotransferrin	LTF	T
Laminin 5, alpha 3	LAMA3	G
Laminin 5, beta 3	LAMB3	G
Laminin 5, gamma 2	LAMC2	G
Laminin M	LAMM	G
Laminin receptor 1	LAMR1	G
Latent transforming growth factor-beta binding protein 2	LTBP2	G
Lectin, mannose-binding 1	LMAN1	I
Lectin, mannose-binding 2	MBL2	I
Leptin	LEP	G
Leptin receptor	LEPR	G
Leukaemia inhibitory factor	LIF	G
Leukaemia inhibitory factor receptor	LIFR	G
Leukin		I
Leukocyte-specific transcript 1	LST-1	I
Leukotriene A4 hydrolase		I
Leukotriene A4 synthase	LTA4S	E
Leukotriene B4 receptor		I
Leukotriene B4 synthase	LTB4S	E
Leukotriene C4 receptor		I
Leukotriene C4 synthase	LTC4S	E
Leukotriene D4/E4 receptor		I
LIM homeobox protein 1	LHX1	G
LIM homeobox protein 2	LHX2	G
LIM homeobox protein 3	LHX3	G
LIM homeobox protein 4	LHX4	G
LIM-domain only protein 1	LMO1	G
LIM-domain only protein 2	LMO2	G
LIM-domain only protein 3	LMO3	G
LIM-domain only protein 4	LMO4	G
LIM-Kinase I (LINK-I)		I
Lipocortin 1	ANX4	I
Lipoprotein-associated coagulation factor	LACI	I
Lipoxygenase 12 (platelets)	LOG12	I
Lipoxygenase 5 (leukocytes)		I

Lymphoblastic leukemia derived sequence 1	LYL1	I
Lymphocyte-specific protein tyrosine kinase	LCK	I
Lymphoid enhancer-binding factor	LEF-1	G
lymphotoxin		I
Lysozyme	LYZ	I
Macrophage activating factor	MAF	I
Macrophage inflammatory protein-1	MIP1	I
Macrophage inflammatory protein-1 receptor		I
Macrophage inflammatory protein-2	MIP2	I
Macrophage inflammatory protein-2 receptor		I
MAD (mothers against decapentaplegic, Drosophila) homologue 3	MADH3	G
MAD (mothers against decapentaplegic, Drosophila) homologue 4	MADH4	G
Malignant proliferation, eosinophil gene	MPE	I
Mannose binding protein	MBP	I
Mannosidase, alpha B lysosomal	MANB	E
Marenostrin	MEFV	T
Matrix metalloproteinase 1	MMP1	E
Matrix metalloproteinase 10	MMP10	E
Matrix metalloproteinase 11	MMP11	E
Matrix metalloproteinase 12	MMP12	E
Matrix metalloproteinase 13	MMP13	E
Matrix metalloproteinase 14	MMP14	E
Matrix metalloproteinase 15	MMP15	E
Matrix metalloproteinase 16	MMP16	E
Matrix metalloproteinase 17	MMP17	E
Matrix metalloproteinase 18	MMP18	E
Matrix metalloproteinase 19	MMP19	E
Matrix metalloproteinase 2	MMP2	E
Matrix metalloproteinase 3	MMP3, STMY1	E
Matrix metalloproteinase 4	MMP4	E
Matrix metalloproteinase 5	MMP5	E
Matrix metalloproteinase 6	MMP6	E
Matrix metalloproteinase 7	MMP7	E
Matrix metalloproteinase 8	MMP8	E
Matrix metalloproteinase 9	MMP9	E
MHC Class I: A		I
MHC Class I: B		I
MHC Class I: C		I
MHC Class I: LMP-2, LMP-7		I
MHC Class I: Tap1	ABCR, TAP1	I
MHC Class II: DP	HLA-DPB1	I
MHC Class II: DQ		I
MHC Class II: DR		I
MHC Class II: Tap2	TAP2, PSF2	I
MHC Class II:Complementation group A	MHC2TA	I
MHC Class II:Complementation group B	rfxank	I

MHC Class II:Complementation group C	RFX5	I
MHC Class II:Complementation group D	RFXAP	I
Monocyte chemoattractant protein 1	MCP1	I
Mucin 18	MUC18	T
Mutated in colorectal cancers, MCC	MCC	G
MutL homolog 1	MLH1	G
MutS homolog 2	MSH2	G
MutS homolog 3	MSH3	G
Myeloid leukemia factor-1	MLF1	I
Myeloperoxidase	MPO	I
Myoglobin		T
Myosin 5A	MYO5A	S
N-acyl hydrolase		I
NADPH oxidase		I
NADPH-dependent cytochrome P450 reductase	POR	E
Natural resistance-associated macrophage protein 1	NRAMP1	I
NB6		I
Nerve growth factor	NGF	G
Nerve growth factor receptor	NGFR	G
Neurofibromin 1	NF1	G
Neurofibromin 2	NF2	G
Neurokinin A	NKNA	N
Neurokinin B	NKNB	N
Neuropeptide Y	NPY	N
Neuropeptide Y receptor Y1	NPY1R	N
Neuropeptide Y receptor Y2	NPY2R	N
Neutral endopeptidase		E
Neutrophil cystolic factor 1	NCF1	I
Neutrophil cystolic factor 2	NCF2	I
Nitric oxide synthase 1, NOS1	NOS1	E
Nitric oxide synthase 2, NOS2	NOS2	E
Nitric oxide synthase 3, NOS3	NOS3	E
Norrie disease protein	NDP	G
Notch 3	NOTCH3	G
Notch ligand - jagged 1	JAG1, AGS	G
Nuclear factor I-kappa-B-like gene	IKBL	I
Nuclear factor kappa beta	NFKB	I
Nuclear factor of activated T cells (NFAT) complex, cytosolic	NFATC	G
Nuclear factor of activated T cells (NFAT) complex, preexisting component	NFATP	G
Nucleoside diphosphate kinase-A	NDPKA	E
Oncogene bcl2		G
Oncogene ELK1	ELK1	G
Oncogene ELK2	ELK2	G
Oncogene ERG (early response gene)		G

Oncogene GLI1	GLI	G
Oncogene GLI2	GLI2	G
Oncogene GLI3	GLI3	G
Oncogene spi1		G
Oncogene TEL	ETV6	G
Oncostatin M	OSM	G
Oncostatin M receptor	OSMR	G
Ornithine delta-aminotransferase	OAT	E
Osteonectin	ON	G
Osteopontin	OPN	G
Paired box homeotic gene 3	PAX3	G
Paired box homeotic gene 7	PAX7	G
Patched (Drosophila) homolog, PTCH	PTCH	G
Peanut-like 1	PNUTL1	I
Phagocytin		I
Phenylethanolamine N-methyltransferase, PNMT	PNMT	E
Phosphatidylinositol glycan, class A (paroxysmal nocturnal hemoglobinuria)	PIGA	G
Phospholipase A2, group 10	PLA2G10	I
Phospholipase A2, group 1B	PLA2G1B	I
Phospholipase A2, group 2A	PLA2G2A	I
Phospholipase A2, group 2B	PLA2G2B	I
Phospholipase A2, group 4A	PLA2G4A	I
Phospholipase A2, group 4C	PLA2G4C	I
Phospholipase A2, group 5	PLA2G5	I
Phospholipase A2, group 6	PLA2G6	I
Phospholipase C alpha		I
Phospholipase C beta		I
Phospholipase C delta	PLCD1	I
Phospholipase C epsilon		I
Phospholipase C gamma	PLCG1	I
Phosphomannomutase-2	PMM2	T
Plakophilin 1	PKP1	T
Plasminogen	PLG	E
Plasminogen activator inhibitor 1	PAI1	E
Plasminogen activator inhibitor 2	PAI2	E
Plasminogen activator receptor, Urokinase	UPAR; PLAUR	S
Plasminogen activator, Tissue	PLAT; TPA	E
Plasminogen activator, Urokinase	UPA; PLAU	E
Platelet glycoprotein 1b, alpha	GP1BA	I
Platelet glycoprotein 1b, beta	GP1BB	I
Platelet glycoprotein 1b, gamma	GP1BG	I
Platelet glycoprotein IX	GP9	I
Platelet glycoprotein V	GP5	I
Platelet-activating factor acetylhydrolase 1B	PAFAH1B1 or LIS1	I
Platelet-activating factor acetylhydrolase 2	PAFAH2	I
Platelet-activating factor receptor	PAFR	I

Poliovirus receptor	PVR, PVS	I
Potassium channel, calcium-activated,	KCNN4	N
Potassium inwardly-rectifying channel J1	KCNJ1	N
Potassium inwardly-rectifying channel J11	KCNJ11	N
Potassium voltage-gated channel A1	KCNA1	N
Potassium voltage-gated channel E1	KCNE1	N
Potassium voltage-gated channel Q1	KCNQ1	N
Potassium voltage-gated channel Q2	KCNQ2	N
Potassium voltage-gated channel Q3	KCNQ3	N
Prekallikrein		I
Preproenkephalin	PENK	N
Procollagen N-protease		E
Promyelocytic leukemia gene	PML	G
Proopiomelanocortin	POMC	N
Properdin P factor, complement	PFC, PFD	I
Prostacyclin synthase		I
Prostaglandin (PG) D synthase, hematopoietic	PGDS	E
Prostaglandin 15-OH dehydrogenase	HGPD; PGDH	I
Prostaglandin D - DP receptor		I
Prostaglandin E1 receptor		I
Prostaglandin E2 receptor		I
Prostaglandin E3 receptor		I
Prostaglandin F - FP receptor		I
Prostaglandin I2 receptor		T
Prostaglandin IP receptor		I
Prostaglandin isomerase		G
Prostaglandin-endoperoxidase synthase 2	PTGS2	G
Protease inhibitor 1		T
Protein C	PROC	I
Protein C inhibitor	PCI	I
Protein kinase A		E
Protein kinase C, alpha	PRKCA	E
Protein kinase C, gamma	PRKCG	E
Protein kinase DNA-activated	PRKDC	E
Protein kinase G		E
Protein phosphatase 1, regulatory (inhibitor) subunit 3	PPP1R3	E
Protein phosphatase 2, regulatory subunit A, beta isoform	PPP2R1B	E
Protein S	PROS1	I
Protein tyrosine phosphatase, non-receptor type 12	PTPN12	G
Proteinase 3		I
Prothrombin precursor	F2	I
Purine nucleoside phosphorylase	NP	E
Pyruvate decarboxylase	PDHA	E
Retinoblastoma 1	RB1	G
Retinol binding protein 4	RBP4	T

Rhesus blood group, CcEe antigens	RHCE	T
Rhesus blood group, D antigen	RHD	T
Rhesus blood group-associated glycoprotein	RHAG	T
Ribosomal protein S19	RPS19	E
RIGUI	RIGUI	G
S100 calcium-binding protein A1	S100A1	N
S100 calcium-binding protein A2	S100A2	N
S100 calcium-binding protein A3	S100A3	N
S100 calcium-binding protein A4	S100A4	N
S100 calcium-binding protein A5	S100A5	N
S100 calcium-binding protein A6	S100A6	N
S100 calcium-binding protein A7	S100A7	N
S100 calcium-binding protein A8	S100A8	N
S100 calcium-binding protein A9	S100A9	N
S100 calcium-binding protein B	S100B	N
S100 calcium-binding protein P	S100P	N
SAP (SLAM-associated protein)	SH2D1A	I
Selectin E	SELE	N
Selectin L	SELL	N
Selectin P	SELP	N
Serotonin receptor, 5HT1A	HTR1A	N
Serotonin receptor, 5HT1B	HTR1B	N
Serotonin receptor, 5HT1C	HTR1C	N
Serotonin receptor, 5HT1D	HTR1D	N
Serotonin receptor, 5HT1E	HTR1E	N
Serotonin receptor, 5HT1F	HTR1F	N
Serotonin receptor, 5HT2A	HTR2A	N
Serotonin receptor, 5HT2B	HTR2B	N
Serotonin receptor, 5HT2C	HTR2C	N
Serotonin receptor, 5HT3	HTR3	N
Serotonin receptor, 5HT4	HTR4	N
Serotonin receptor, 5HT5	HTR5	N
Serotonin receptor, 5HT6	HTR6	N
Serotonin receptor, 5HT7	HTR7	N
Severe combined immunodeficiency, type A (Athabaskan)	SCIDA	I
Signal transducer and activator of transcription 1	STAT1	G
Signal transducer and activator of transcription 2	STAT2	G
Signal transducer and activator of transcription 3	STAT3	G
Signal transducer and activator of transcription 4	STAT4	G
Signal transducer and activator of transcription 5	STAT5	G
Signaling lymphocyte activation molecule	SLAM	I
Sine oculis homeobox, drosophila, homolog 1	SIX1	G

Sine oculis homeobox, drosophila, homolog 2	SIX2	G
Sjogren (Sjogren) syndrome antigen A1	SSA1	I
Sodium channel, non-voltage gated 1, alpha	SCNN1A	N
Sodium channel, non-voltage gated 1, beta	SCNN1B	N
Sodium channel, non-voltage gated 1, gamma	SCNN1G	N
Sodium channel, voltage gated, type V, alpha polypeptide	SCN5A	N
Sodium channel, voltage-gated, type 1, beta polypeptide	SCN1B	N
Solute carrier family 19 (folate transporter), member 1	SLC19A1	T
Solute carrier family 20, member 1	SLC20A1	T
Solute carrier family 20, member 2	SLC20A2	T
Solute carrier family 5 (sodium/glucose transporter), member 1	SLC5A1	T
Solute carrier family 5 (sodium/glucose transporter), member 2	SLC5A2	T
Solute carrier family 5 (sodium/glucose transporter), member 5	SLC5A5	T
Solute carrier family 5, member 3	SLC5A3	T
Sorcin	SRI	T
Sperm protamine P1	PRM1	G
Sperm protamine P2	PRM2	G
Stem cell factor	SCF	G
Stromal derived factor 1	SDF1	G
Succinate dehydrogenase 1	SDH1	E
Succinate thiokinase		E
Superoxide dismutase 1	SOD1	E
Superoxide dismutase 3	SOD3	E
SYK-related tyrosine kinase	SRK	I
Talin	TLN	G
Talin, TLN		S
T-cell acute lymphocytic leukemia 1	TAL1	I
T-cell acute lymphocytic leukemia 2	TAL2	I
T-cell receptor, alpha	TCRA	I
T-cell receptor, delta	TCRD	I
Tenascin (cytotactin)		S
Tenascin XA	TNXA	S
Terminal deoxynucleotidyltransferase	TDT	I
Terminal deoxynucleotidyltransferase, TDT		E
Thrombin receptor	F2R	I
Thrombopoietin	THPO	G
Thrombospondin	THBS1	G
Thromboxane A synthase 1	TBXAS1	I
Thromboxane A2	TXA2	I
Thromboxane A2 receptor	TBXA2R	I
Thy-1 T-cell antigen	THY1	I
Thymic humoral factor		I

Thymopoietin	TMPO	G
Thymosin		I
TIE receptor tyrosine kinase	TIE-1	G
Tip-associated protein	TAP	I
Toll-like receptor 4	TLR4	I
Topoisomerase I		E
Topoisomerase II		E
Transcobalamin 2, TCN2	TCN2	T
Transcription factor 3	TCF3	G
Transcription factor binding to IGHM enhancer 3	TFE3	G
Transferrin	TF	G
Transferrin receptor	TFRC	G
Transforming growth factor, alpha	TGFA	G
Transforming growth factor, beta 2	TGFB2	G
Transforming growth factor, beta induced	TGFBI	G
Transforming growth factor, beta receptor 2	TGFBR2	G
Tuberous sclerosis 1	TSC1	G
Tuberous sclerosis 2	TSC2	G
Tubulin		S
Tumor susceptibility gene 101	TSG101	G
Tumour necrosis factor (TNF) receptor associated factor 1	TRAF1	I
Tumour necrosis factor (TNF) receptor associated factor 2	TRAF2	I
Tumour necrosis factor (TNF) receptor associated factor 3	TRAF3	I
Tumour necrosis factor (TNF) receptor associated factor 4	TRAF4	I
Tumour necrosis factor (TNF) receptor associated factor 5	TRAF5	I
Tumour necrosis factor (TNF) receptor associated factor 6	TRAF6	I
Tumour necrosis factor alpha	TNFA	I
Tumour necrosis factor alpha receptor	TNFAR	I
Tumour necrosis factor beta	TNFB	I
Tumour necrosis factor beta receptor	TNFBR	I
Tumour protein p53	TP53, P53	G
Tumour protein p63	TP63	G
Tumour protein p73	TP73	G
Tumour protein, translationally-controlled 1	TPT1	G
Tumour suppressor gene DRA	DRA	I
Ubiquitin		G
Ubiquitin activating enzyme, E1		E
Ubiquitin B	UBB	G
Ubiquitin C	UBC	G
Ubiquitin fusion degeneration 1-like	UFD1L	G
Ubiquitin protein ligase E3A	UBE3A	E



Undulin 1	COL14A1	S
Uridine monophosphate kinase	UMPK	I
Uridine monophosphate synthetase	UMPS	I
Uroporphyrinogen III synthase	UROS	E
Vimentin	VIM	I
v-myc avian myelocytomatosis viral oncogene homolog	MYC	G
Von Hippel-Lindau gene	VHL	G
Werner syndrome helicase	WRN	G
Wilms tumour gene 1	WT1	G
Wilms tumour gene 2	WT2	G
Wilms tumour gene 4	WT4	G
Winged helix nude	WHN	G
Wiskott-Aldrich syndrome protein	WASP, THC	I
Xanthine dehydrogenase	XDH	E
X-ray repair gene	XRCC9	G
Zinc finger protein 198	ZIC198	S
Zinc finger protein HRX	ALL1	I

In a twelfth aspect.

## DEVELOPMENT

The present invention relates to a method of assessing the risk of developing clinical or social consequences following dysfunction, damage or disease of the body consequent to an aberration in the processes of development and indicating appropriate therapeutic interventions.

The process by which fertilisation of an egg leads to the formation and growth of a foetus, birth of a baby and the maturation of an adolescent into an adult are collectively described as development. An understanding of the genetic and molecular events directing the development and differentiation of cells into tissues and organs is slowly being understood (Gilbert 1997). The intricate nature of the interactions between cells as they divide and differentiate is mediated by a host of regulatory systems including:

DNA methylation

Transcriptional regulation (e.g. POU transcription factors)

Differential RNA splicing

Paracrine systems

Signal transduction pathways (e.g. RTK-Ras, JAK-STAT, NOTCH)

Neurotransmitter/receptor interaction

Cell surface adhesion molecules

In addition there are significant interactions between the developing organism and the environment (the womb and subsequently the external environment). In humans the process of development and maturation continues through to late 20's as the final stages of brain myelination occur.

The sheer complexity of these interactions and their subtle effects on the dynamics of organ formation and development mean that there are multiple opportunities for perturbation, failure or premature termination of the developmental trajectory. No tissue, organ or organ system in the body is immune to the possibility of dysfunction, damage or disease consequent to an aberration in the processes of development.

The spectrum of medical, psychological and social consequences consequent to an aberration in developmental processes is enormous (Weatherall, Leadingham and Warrell 1996). For example abnormalities of brain development are very frequent and often lead to lasting impairments in cognition and learning (some 3% of school leavers may have some degree of neurological impairment. Developmental disorders include:

Down's syndrome (brain and other organs)

Cruzon syndrome (skull)

Congenital adrenal hyperplasia (endocrine system)

Congenital hypothyroidism (endocrine system)

Hirschsprung's disease (gastrointestinal system)

Pyloric stenosis (gastrointestinal system)

Aortic-valve stenosis (cardiovascular system)

Mitral valve abnormalities (cardiovascular system)

Spina bifida (spine)

Cerebral palsy (central nervous system)

Cystic fibrosis (respiratory system)

The physiology and nature of dysfunction, damage or disease of the body consequent to an aberration in the processes of development are extremely complex. The exact spectrum of symptoms and attendant disability are derived from the nature of the lesion, its site and extent and the time at which it influenced the pattern of development. The presence of a clinical, psychological or social liability may also change over time since the manifestations of the difficulties at birth, adolescence or adulthood will alter as a function of the unfolding of development

The interactions between the various proteins which form the constituent parts of the regulatory systems are critical in the control and modulation of development. Variation in the functionality of the proteins involved in these processes will, inevitably, cause or have an impact on the functioning of these systems or modulate a tissues ability to minimise developmental aberrations and restore function following dysfunction, damage or disease in the development of these systems. A number of constitutional factors are known to impact on the individuals ability to deal with and recover from dysfunction, damage or disease of the body consequent to an aberration in the processes of development. These include genetic history, age, sex, nutritional status, pre-existing disease or injury, drug treatments and socio-economic circumstances.

Genetic variation within individuals is also a key factor although the extent and nature of the genes involved and their precise impact on prognosis, complications, efficacy of therapeutic intervention and eventual recovery of function is largely unknown.

The individual variability in response to the occurrence of dysfunction, damage or disease of the body consequent to an aberration in the processes of development and the associated variation in symptomatology, response to therapy and adverse events resulting from therapeutic interventions lies at the heart of the difficulties experienced in the health and social management of dysfunction, damage or disease of the body consequent to an aberration in the processes of development.

We have elaborated on the value and utility to be derived from the gathering together of the genes which form the core gene list for this particular Genostic system.

These genes are elaborated below:

**KEY TO 'PROTEIN FUNCTION' COLUMN**

E ENZYME  
 T TRANSPORT & STORAGE  
 S STRUCTURAL  
 I IMMUNITY  
 N NERVOUS TRANSMISSION  
 G GROWTH & DIFFERENTIATION

**DEVELOPMENT GENE LIST**

	<b>HUGO gene symbol</b>	<b>Protein function</b>
17-ketosteroid reductase		N
2,4-dienoyl CoA reductase	DECR	E
3 beta hydroxysteroid dehydrogenase 2	HSD3B2	E
3-oxoacid CoA transferase	OXCT	E
6-pyruvoyltetrahydropterin synthase	PTS	E
Absent in melanoma 1 gene	AIM1	G
Acetoacetyl 2-CoA-thiolase	ACAT2	E
Acetyl CoA acyltransferase	ACAA	E
Acetyl CoA carboxylase alpha	ACACA	E
Acetylcholine receptor, nicotinic, alpha A1	CHRNA1	N
Acetylcholine receptor, nicotinic, alpha A2	CHRNA2	N
Acetylcholine receptor, nicotinic, alpha A3	CHRNA3	N
Acetylcholine receptor, nicotinic, alpha A4	CHRNA4	N
Acetylcholine receptor, nicotinic, alpha A5	CHRNA5	N
Acetylcholine receptor, nicotinic, alpha A6	CHRNA6	N
Acetylcholine receptor, nicotinic, alpha A7	CHRNA7	N
Acetylcholine receptor, nicotinic, beta 1	CHRNA1	N
Acetylcholine receptor, nicotinic, beta 2	CHRNA2	N
Acetylcholine receptor, nicotinic, beta 3	CHRNA3	N
Acetylcholine receptor, nicotinic, beta 4	CHRNA4	N
Acetylcholine receptor, nicotinic, epsilon	CHRNA5	N
Acetylcholine receptor, nicotinic, gamma	CHRNA6	N
Acetylcholinesterase	ACHE	E
Achromatopsia 2	ACHM2	S
Acid phosphatase 2, lysosomal	ACP2	E
Acrosin	ACR	G
Actin, alpha, cardiac	ACTC	S
Actin, alpha, skeletal	ACTA1	S
Actin, alpha, smooth, aortic	ACTA2	S
Activin		G
Activin A receptor, type 2B	ACVR2B	G
Activin A receptor, type 2-like kinase 1	ACVRL1	G
Acyl CoA dehydrogenase, short chain	ACADS	E
Acyl-CoA thioesterase		E
ADAM (A disintegrin and metalloproteinase) 1	ADAM1	E
ADAM (A disintegrin and metalloproteinase) 10	ADAM10	E
ADAM (A disintegrin and metalloproteinase) 11	ADAM11	E

ADAM (A disintegrin and metalloproteinase) 12	ADAM12	E
ADAM (A disintegrin and metalloproteinase) 13	ADAM13	E
ADAM (A disintegrin and metalloproteinase) 14	ADAM14	E
ADAM (A disintegrin and metalloproteinase) 15	ADAM15	E
ADAM (A disintegrin and metalloproteinase) 16	ADAM16	E
ADAM (A disintegrin and metalloproteinase) 17	ADAM17	E
ADAM (A disintegrin and metalloproteinase) 18	ADAM18	E
ADAM (A disintegrin and metalloproteinase) 19	ADAM19	E
ADAM (A disintegrin and metalloproteinase) 2	ADAM2	E
ADAM (A disintegrin and metalloproteinase) 3A	ADAM3A	E
ADAM (A disintegrin and metalloproteinase) 3B	ADAM3B	E
ADAM (A disintegrin and metalloproteinase) 4	ADAM4	E
ADAM (A disintegrin and metalloproteinase) 5	ADAM5	E
ADAM (A disintegrin and metalloproteinase) 6	ADAM6	E
ADAM (A disintegrin and metalloproteinase) 7	ADAM7	E
ADAM (A disintegrin and metalloproteinase) 8	ADAM8	E
ADAM (A disintegrin and metalloproteinase) 9	ADAM9	E
Adducin, alpha	ADD1	S
Adducin, beta	ADD2	S
Adenomatous polyposis coli tumour suppressor gene	APC	G
Adenosine deaminase	ADA	E
Adenosine monophosphate deaminase	AMPD	E
Adenosine receptor A1	ADORA1	N
Adenosine receptor A2A	ADORA2A	N
Adenosine receptor A2B	ADORA2B	N
Adenosine receptor A3	ADORA3	N
Adenyl cyclase		N
Adenylate cyclase 1	ADCY1	E
Adenylate cyclase 2	ADCY2	E
Adenylate cyclase 3	ADCY3	E
Adenylate cyclase 4	ADCY4	E
Adenylate cyclase 5	ADCY5	E
Adenylate cyclase 6	ADCY6	E
Adenylate cyclase 7	ADCY7	E
Adenylate cyclase 8	ADCY8	E
Adenylate cyclase 9	ADCY9	E
Adenylosuccinate lyase	ADSL	E
ADP-ribosyltransferase	ADPRT	E
Adrenergic receptor, alpha1	ADRA1	N
Adrenergic receptor, alpha2	ADRA2	N
Adrenergic receptor, beta1	ADRB1	N
Adrenergic receptor, beta2	ADRB2	N
Adrenergic receptor, beta3	ADRB3	N
Adrenocorticotrophic hormone (ACTH) receptor	ACTHR	G

Adrenoleukodystrophy gene	ALD	E
Alanine-glyoxylate aminotransferase	AGXT	E
Albumin, ALB	ALB	T
Aldehyde dehydrogenase 1	ALDH1	E
Aldehyde dehydrogenase 10	ALDH10	E
Aldehyde dehydrogenase 2	ALDH2	E
Aldehyde dehydrogenase 5	ALDH5	E
Aldehyde dehydrogenase 6	ALDH6	E
Aldehyde dehydrogenase 7	ALDH7	E
Aldolase A	ALDOA	E
Aldolase B	ALDOB	E
Aldolase C	ALDOC	E
Aldosterone receptor	MLR	G
Alkaline phosphatase, liver/bone/kidney	ALPL	T
Alkaptonuria gene	AKU	G
Alkylglycerone phosphate synthase	AGPS	E
Alpha 2 macroglobulin	A2M	I
alpha tectorin	TECTA	G
alpha thalassemia gene	ATRX	N
alpha1-antitrypsin	PI	E
alpha2-antiplasmin	PLI	E
alpha-actinin 2	ACTN2	G
alpha-actinin 3	ACTN3	G
alpha-amylase		E
Alpha-fetoprotein	AFP	G
alpha-Galactosidase A	GLA	E
alpha-ketoglutarate dehydrogenase		E
alpha-L-Iduronidase	IDUA	E
alpha-synuclein	SNCA	N
Amelogenin	AMELX	S
Aminomethyltransferase	AMT	E
Aminopeptidase P	XPNPEP2	E
Amphiregulin	AREG	G
Amylo-1,6-glucosidase	AGL	E
Amyloid beta (A4) precursor protein-binding, APBB1	APBB1	N
Amyloid beta A4 precursor protein	APP	N
Amyloid beta A4 precursor-like protein	APLP	N
Androgen binding protein	ABP	T
Androgen receptor	AR	G
Angiopoietin 1	ANGPT1	G
Angiopoietin 2	ANGPT2	G
Angiotensin converting enzyme	ACE, DCP1	E
Angiotensinogen	AGT	E
Ankyrin 1	ANK1	S
Ankyrin 2	ANK2	S
Ankyrin 3	ANK3	S
Antidiuretic hormone receptor	ADHR	T

Anti-Mullerian hormone	AMH	G
Anti-Mullerian hormone type 2 receptor	AMHR2	G
Antithrombin III	AT3	E
AP-2, alpha	TFAP2A	G
AP-2, beta	TFAP2B	G
AP-2, gamma	TFAP2C	G
Apaf-1		S
Apical protein, xenopus laevis-like	APXL	G
Apolipoprotein A 4	APOA4	T
Apolipoprotein A I	APOA1	T
Apolipoprotein A II	APOA2	T
Apolipoprotein B	APOB	T
Apolipoprotein C1	APOC1	T
Apolipoprotein C2	APOC2	T
Apolipoprotein C3	APOC3	T
Apolipoprotein D	APOD	T
Apolipoprotein E	APOE	T
Apolipoprotein H	APOH	T
Apopain	CPP32	G
Apoptosis antigen 1	APT1	I
Apoptosis antigen ligand 1	APT1LG1	I
Apoptosis-inducing factor	AIF	I
Apurinic endonuclease	APE	E
Archaete-scute homolog 1	ASH1	G
Archaete-scute homolog 2	ASH2	G
Arginosuccinate synthetase	ASS	E
Arrestin	SAG	S
Aryl hydrocarbon receptor	AHR	T
Aryl hydrocarbon receptor nuclear translocator	ARNT	T
Arylsulfatase A	ARSA	E
Arylsulfatase B	ARSB	E
Arylsulfatase C	ARSC1	E
Arylsulfatase D	ARSD	E
Arylsulfatase E	ARSE	E
Arylsulfatase F	ARSF	E
Aspartate transaminase		T
Aspartate transcarbamoylase		E
Aspartoacylase	ASPA	E
Aspartylglucosaminidase	AGA	E
Astrotactin	ASTN	G
Ataxia telangiectasia complementation group D	ATD, ATDC	G
Ataxia telangiectasia gene, AT	ATM	G
Ataxin 1	SCA1	G
Ataxin 2	SCA2	G
Ataxin 3	MJD	G
ATP-binding cassette transporter 7	ABC7	I
Atrial natriuretic peptide	ANP	G
Atrial natriuretic peptide receptor A	NPR1	G

Atrial natriuretic peptide receptor B	NPR2	G
Atrial natriuretic peptide receptor C	NPR3	G
Atrophin 1	DRPLA	G
Attractin		I
Autoimmune regulator, AIRE	AIRE	I
Azoospermia factor 1	AZF1	G
Bagpipe homeobox, drosophila homolog of, 1	BAPX1	G
B-cell CLL/lymphoma 1	BCL1	I
B-cell CLL/lymphoma 10	BCL10	I
B-cell CLL/lymphoma 3	BCL3	I
B-cell CLL/lymphoma 4	BCL4	I
B-cell CLL/lymphoma 5	BCL5	I
B-cell CLL/lymphoma 6	BCL6	I
B-cell CLL/lymphoma 7	BCL7	I
B-cell CLL/lymphoma 8	BCL8	I
B-cell CLL/lymphoma 9	BCL9	I
BCL2-associated X protein	BAX	G
BCL2-related protein A1	BCL2A1	G
Beckwith-Wiedemann region 1A	BWR1A	G
Bestrophin	VMD2	T
beta 2 microglobulin	B2M	I
beta-endorphin receptor		N
beta-Glucuronidase	GUSB	E
beta-N-acetylhexosaminidase, A		E
beta-N-acetylhexosaminidase, B		E
Bilirubin UDP-glucuronosyltransferase		E
Bleomycin hydrolase	BLMH	E
Bloom syndrome protein	BLM	G
Blue cone pigment	BCP	S
Bone morphogenetic protein, BMP1	BMP1	G
Bone morphogenetic protein, BMP2	BMP2	G
Bone morphogenetic protein, BMP3	BMP3	G
Bone morphogenetic protein, BMP4	BMP4	G
Bone morphogenetic protein, BMP5	BMP5	G
Bone morphogenetic protein, BMP6	BMP6	G
Bone morphogenetic protein, BMP7	BMP7	G
Bone morphogenetic protein, BMP8	BMP8	G
Brain derived neurotrophic factor	BDNF	G
Brain derived neurotrophic factor (BDNF) receptor	BDNFR	G
Branched chain aminotransferase 1, cytosolic	BCAT1	E
Branched chain aminotransferase 2, mitochondrial	BCAT2	E
BRCA1-associated RING domain gene 1	BARD1	G
Breakpoint cluster region	BCR	G
Breast cancer 1	BRCA1	G
Breast cancer 2	BRCA2	G
Breast cancer, ductal, 1	BRCD1	G



Breast cancer, ductal, 2	BRCD2	G
Bruton agammaglobulinaemia tyrosine kinase	BTK	G
Butyrylcholinesterase	BCHE	E
C3 convertase		E
Ca(2+) transporting ATPase, fast twitch	ATP2A1	T
Ca(2+) transporting ATPase, slow twitch	ATP2A2	T
Cadherin E	CDH1	G
Cadherin EP		G
Cadherin N	CDH2	G
Cadherin P	CDH3	G
Calbindin 1	CALB1	G
Calbindin D9K	CALB3	G
Calcium channel, voltage-dependent, alpha 1F subunit	CACNA1F	N
Calcium channel, voltage-dependent, Alpha-1B (CACNL1A5)	CACNA1B	N
Calcium channel, voltage-dependent, Alpha-1C	CACNA1C	N
Calcium channel, voltage-dependent, Alpha-1D	CACNA1D	N
Calcium channel, voltage-dependent, Alpha-1E (CACNL1A6)	CACNA1E	N
Calcium channel, voltage-dependent, Alpha-2/delta	CACNA2	N
Calcium channel, voltage-dependent, Beta 1	CACNB1	N
Calcium channel, voltage-dependent, Beta 3	CACNB3	N
Calcium channel, voltage-dependent, L type, alpha 1S subunit	CACNA1S	N
Calcium channel, voltage-dependent, Neuronal, Gamma	CACNG2	N
Calcium channel, voltage-dependent, P/Q type, alpha 1A subunit	CACNA1A	N
Calcium channel, voltage-dependent, T-type		N
Calcium sensing receptor	CASR	T
Calmodulin 1	CALM1	G
Calmodulin 2	CALM2	G
Calmodulin 3	CALM3	G
Calmodulin dependant kinase		T
Calmodulin-dependant protein kinase II	CAMK2A	G
Calnexin	CANX	G
Calpain	CAPN, CAPN3	E
Canalicular multispecific organic anion transporter	CMOAT	T
Carbamoylphosphate synthetase 1	CPS1	E
Carbamoylphosphate synthetase 2	CPS2	E
Carbonic anhydrase 3	CA3	E
Carbonic anhydrase 4	CA4	E
Carbonic anhydrase, alpha	CA1	E

Carbonic anhydrase, beta	CA2	E
Cardiac-specific homeobox, CSX	CSX	G
Carnitine acetyltransferase	CRAT	E
Carnitine acylcarnitine translocase	CACT	E
Carnitine transporter protein	CDSP, SCD	T
Cartilage oligomeric matrix protein	COMP, EDM1, PSACH	N
Cartilage-hair hypoplasia gene	CHH	N
Caspase 1	CASP1	G
Caspase 10	CASP10	G
Caspase 2	CASP2	G
Caspase 3	CASP3	G
Caspase 4	CASP4	G
Caspase 5	CASP5	G
Caspase 6	CASP6	G
Caspase 7	CASP7	G
Caspase 8	CASP8	G
Caspase 9	CASP9	G
Catechol-O-methyltransferase	COMT	E
Catenin, alpha	CTNNA1	G
Catenin, beta	CTNNB1	G
Catenin, gamma		G
Cathepsin K	CTSK	E
Caveolin 3	CAV3	E
CD1	CD1	I
CD44	CD44	I
Cdc 25 phosphatase		G
Cdc2	CDC2	G
CDX1		G
CEA		G
Cell adhesion molecule, intercellular, ICAM	ICAM1	G
Cell adhesion molecule, leukocyte-endothelial, LECAM (CD62)	LECAM1	G
Cell adhesion molecule, liver, LCAM	LCAM	G
Cell adhesion molecule, neural, NCAM1	NCAM1	G
Cell adhesion molecule, neural, NCAM120	NCAM120	G
Cell adhesion molecule, neural, NCAM2	NCAM2	G
Cell adhesion molecule, platelet-endothelial, PECAM	PECAM1	G
Cell adhesion molecule, vascular, VCAM	VCAM1	G
Cellubrevin	CEB	N
c-erbB1	ERBB1	G
c-erbB2	ERBB2	G
c-erbB3	ERBB3	G
c-erbB4	ERBB4	G
Ceroid lipofuscinosis neuronal 2	CLN2	N
Ceroid lipofuscinosis neuronal 3	CLN3	N
Ceroid lipofuscinosis neuronal 4	CLN4	N

Ceroid lipofuscinosis neuronal 5	CLN5	N
Ceroid lipofuscinosis neuronal 6	CLN6	N
Chediak-Higashi syndrome 1 gene	CHS1	T
Chemokine MCAF	MCAF	I
Chemokine receptor CCR2	CCR2	I
Chemokine receptor CCR3	CCR3	I
Chemokine receptor CCR5	CCR5	I
Chemokine receptor CXCR1	CXCR1	I
Chemokine receptor CXCR2	CXCR2	I
Chemokine receptor CXCR4	CXCR4	I
Chloride channel 5	CLCN5	S
Cholestasis, progressive familial intrahepatic 1 gene	FIC1	G
Cholesterol ester transfer protein	CETP	T
Choline acetyltransferase	CHAT	E
Choroideremia gene	CHM	S
Chromogranin A	CHGA	G
Ciliary neurotrophic factor (CNTF)	CNTF	G
Ciliary neurotrophic factor (CNTF) receptor	CNTFR	G
c-kit receptor tyrosine kinase		G
Clathrin		T
Cleavage signal-1 protein	CS1	G
Cleft palate gene	CPX	G
Clusterin	CLU	G
CoA transferase		E
Cochlin	COCH	I
Cockayne syndrome gene, CKN1	CKN1	G
Collagen I alpha 1	COL1A1	S
Collagen I alpha 2	COL1A2	S
Collagen II alpha 1	COL2A1	S
Collagen III alpha 1	COL3A1	S
Collagen IV alpha 1	COL4A1	S
Collagen IV alpha 2	COL4A2	S
Collagen IV alpha 3	COL4A3	S
Collagen IV alpha 4	COL4A4	S
Collagen IV alpha 5	COL4A5	S
Collagen IV alpha 6	COL4A6	S
Collagen IX alpha 2	COL9A2, EDM2	S
Collagen IX alpha 3	COL9A3	S
Collagen receptor	COLR	S
Collagen V alpha 1	COL5A1	S
Collagen V alpha 2	COL5A2	S
Collagen VI alpha 1	COL6A1	S
Collagen VI alpha 2	COL6A2	S
Collagen VI alpha 3	COL6A3	S
Collagen VII alpha 1	COL7A1	S
Collagen X alpha 1	COL10A1	S
Collagen X alpha 1	COL11A1	S

Collagen XI alpha 2	COL11A2	S
Collagen XVII alpha 1	COL17A1	S
Collagenic-like tail subunit of asymmetric acetylcholinesterase	COLQ	E
Collapsin		G
Colony-stimulating factor 1	CSF1	G
Colony-stimulating factor 1 receptor	CSF1R	G
Colony-stimulating factor 2	CSF2	G
Colony-stimulating factor 2 alpha receptor	CSF2RA	G
Colony-stimulating factor 2 beta receptor	CSF2RB	G
Colony-stimulating factor 3	CSF3	G
Colony-stimulating factor 3 receptor	CSF3R	G
Complex V	MTATP6	E
Cone-rod homeobox-containing gene	CRX	G
Contactin	CNTN1	G
Core-binding factor, alpha 1	CBFA1	G
Core-binding factor, alpha 2	CBFA2	G
Core-binding factor, beta	CBFB	G
Corticotrophin-releasing hormone	CRH	T
Corticotrophin-releasing hormone receptor	CRHR1	T
Creatine kinase – B and m	CKBE	E
Creb binding protein	CREBBP	G
Cryptochrome 1	CRY1	S
Cryptochrome 2	CRY2	S
Crystallin, alpha A	CRYAA	S
Crystallin, alpha B	CRYAB	S
Crystallin, beta B2	CRYBB2	S
Crystallin, gamma A	CRYGA	S
c-src tyrosine kinase	CSK	G
Cu <sup>2+</sup> transporting ATPase alpha polypeptide	ATP7A	E
Cu <sup>2+</sup> transporting ATPase beta polypeptide	ATP7B	E
Cubilin	CUBN	T
Cyclic AMP response element binding protein	CREB	G
Cyclic AMP response element modulator	CREM	G
Cyclic AMP-dependent protein kinase	PKA	E
Cyclic nucleotide gated channel alpha 1, CNGA1	CNGA1	N
Cyclic nucleotide gated channel alpha 3, CNGA3	CNGA3	N
Cyclic nucleotide phosphodiesterase 1B	PDE1B	E
Cyclic nucleotide phosphodiesterase 1B1	PDE1B1	E
Cyclic nucleotide phosphodiesterase 2A3	PDE2A3	E
Cyclic nucleotide phosphodiesterase 3A	PDE3A	E
Cyclic nucleotide phosphodiesterase 3B	PDE3B	E
Cyclic nucleotide phosphodiesterase 4A	PDE4A	E
Cyclic nucleotide phosphodiesterase 4C	PDE4C	E
Cyclic nucleotide phosphodiesterase 5A	PDE5A	E
Cyclic nucleotide phosphodiesterase 6A	PDE6A	E

Cyclic nucleotide phosphodiesterase 6B	PDE6B	E
Cyclic nucleotide phosphodiesterase 7	PDE7	E
Cyclic nucleotide phosphodiesterase 8	PDE8	E
Cyclic nucleotide phosphodiesterase 9A	PDE9A	E
Cyclin A	CCNA	G
Cyclin B	CCNB	G
Cyclin C	CCNC	G
Cyclin D	CCND1	G
Cyclin E	CCNE	G
Cyclin F	CCNF	G
Cyclin-dependent kinase 1	CDK1	G
Cyclin-dependent kinase 10	CDK10	G
Cyclin-dependent kinase 2	CDK2	G
Cyclin-dependent kinase 3	CDK3	G
Cyclin-dependent kinase 4	CDK4	G
Cyclin-dependent kinase 5	CDK5	G
Cyclin-dependent kinase 6	CDK6	G
Cyclin-dependent kinase 7	CDK7	G
Cyclin-dependent kinase 8	CDK8	G
Cyclin-dependent kinase 9	CDK9	G
Cyclin-dependent kinase inhibitor 1A (P21, CIP1)	CDKN1A	G
Cyclin-dependent kinase inhibitor 1B (P27, KIP1)	CDKN1B	G
Cyclin-dependent kinase inhibitor 1C (P57, KIP2)	CDKN1C	G
Cyclin-dependent kinase inhibitor 2A (p16)	CDKN2A	G
Cyclin-dependent kinase inhibitor 3	CDKN3	G
Cyclooxygenase 1	COX1	E
Cyclooxygenase 2	COX2	E
CYP11A1	CYP11A1	E
CYP11B1	CYP11B1	E
CYP11B2	CYP11B2	E
CYP17	CYP17	E
CYP19	CYP19	E
CYP1A1	CYP1A1	E
CYP1A2	CYP1A2	E
CYP1B1	CYP1B1	E
CYP21	CYP21	E
CYP24	CYP24	E
CYP27	CYP27	E
CYP27B1	PDDR	E
CYP2A1	CYP2A1	E
CYP2A13	CYP2A13	E
CYP2A3	CYP2A3	E
CYP2A6V2	CYP2A6V2	E
CYP2A7	CYP2A7	E
CYP2B6	CYP2B6	E

CYP2C18	CYP2C18	E
CYP2C19	CYP2C19	E
CYP2C8	CYP2C8	E
CYP2C9	CYP2C9	E
CYP2D6	CYP2D6	E
CYP2E1	CYP2E1	E
CYP2F1	CYP2F1	E
CYP2J2	CYP2J2	E
CYP3A3	CYP3A3	E
CYP3A4	CYP3A4	E
CYP3A5	CYP3A5	E
CYP3A7	CYP3A7	E
CYP4A11	CYP4A11	E
CYP4B1	CYP4B1	E
CYP4F2	CYP4F2	E
CYP4F3	CYP4F3	E
CYP51	CYP51	E
CYP5A1	CYP5A1	E
CYP7A	CYP7A	E
CYP8	CYP8	E
Cystathionase	CTH	E
Cystathione beta synthase	CBS	E
Cystic fibrosis transmembrane conductance regulator, CFTR	CFTR	N
Cystinosin	CTNS	T
Cytidine deaminase	CDA	E
Cytochrome b-245 alpha	CYBA	E
Cytochrome b-245 beta	CYBB	E
Cytochrome b-5	CYB5	E
DAX1 nuclear receptor	DAX1	I
Deafness autosomal dominant 5	DFNA5	N
Deafness dystonia peptide	DDP	N
Defender against cell death 1	DAD1	G
Deleted in azoospermia	DAZ	G
Deleted in colorectal carcinoma	DCC	G
Deleted in malignant brain tumours 1	DMBT1	G
Delta aminolevulinate dehydratase	ALAD	E
Delta(4)-3-oxosteroid 5-beta-reductase		E
Delta-7-dehydrocholesterol reductase	DHCR7	E
Dentin sialophosphoprotein	DSPP	G
Deoxyuridine triphosphatase; dUTPase		E
Desert hedgehog, dhh		G
DHEA sulfotransferase	STD	E
Diaphanous 1	DIAPH1	N
Diaphanous 2	DIAPH2	N
Diastrophic dysplasia sulfate transporter	DTD	T
Dihydrolipoamide branched chain transacylase	DBT	N
Dihydrolipoamide dehydrogenase	DLD	N

Dihydrolipoyl dehydrogenase 2	PDHA	E
Dihydrolipoyl transacetylase	PDHA	E
Dihydroorotase		E
Dihydroxyacetonephosphate acyltransferase	DHAPAT	E
Disrupted meiotic cDNA 1, homolog	DMC1	G
Distal-less homeobox 1	DLX1	G
Distal-less homeobox 2	DLX2	G
Distal-less homeobox 3	DLX3	G
Distal-less homeobox 4	DLX4	G
Distal-less homeobox 5	DLX5	G
Distal-less homeobox 6	DLX6	G
DNA damage binding protein, DDB1	DDB1	S
DNA damage binding protein, DDB2	DDB2	S
DNA directed polymerase, alpha	POLA	E
DNA glycosylases		E
DNA helicases		E
DNA Ligase 1	LIG1	E
DNA methyltransferase	DNMT	E
DNA polymerase 1		E
DNA polymerase 2		E
DNA polymerase 3		E
DNA primase		E
DNA-damage-inducible transcript 3	DDIT3	S
DNA-dependant RNA polymerase		E
DOPA decarboxylase	DDC	E
Doublecortin, DCX	DCX	S
Duffy blood group	FY	T
Dynamin	DNM1	G
Dynein		G
Dyskerin	DKC1	S
Dystonia 1	DYT1	S
Dystonia 3	DYT3	S
Dystonia 6	DYT6	S
Dystonia 7	DYT7	S
Dystonia 9	CSE	S
Dystrophia myotonica	DM, DMPK	E
Dystrophia myotonica, atypical	DM2	E
Dystrophin	DMD	S
Dystrophin-associated glycoprotein 35kD, SCGD	SGCD	S
Dystrophin-associated glycoprotein 35kD, SGSG	SGCG	S
Dystrophin-associated glycoprotein 43kD	SGCB	S
Dystrophin-associated glycoprotein 50kD	SGCA	S
E74-like factor 1, ELF1	ELF1	G
EB1		G
Ectodermal Dysplasia 1 gene	ED1	S
Electron-transferring-flavoprotein alpha	ETFA	T

Electron-transferring-flavoprotein beta	ETFB	T
Electron-transferring flavoprotein dehydrogenase	ETFDH	E
Empty spiracles (drosophila) homologue 1	EMX1	G
Empty spiracles (drosophila) homologue 2	EMX2	G
Endobrevin	VAMP8	N
Endocardial fibroelastosis 2 gene	EFE2	S
Endometrial bleeding-associated factor	EBAF	G
Endothelin 1	EDN1	N
Endothelin 2	EDN2	N
Endothelin 3	EDN3	N
Endothelin converting enzyme	ECE1	N
Endothelin receptor type A	EDNRA	N
Endothelin receptor type B	EDNRB	N
Engrailed-1	EN1	G
Engrailed-2	EN2	G
Enolase	ENO1	E
Enoyl CoA isomerase		E
Enterokinase	PRSS7, ENTK	E
Ephrin receptor tyrosine kinase A	EPHA	G
Ephrin receptor tyrosine kinase B	EPHB	G
Ephrin-A	EFNA	G
Ephrin-B	EFNB	G
Epidermal growth factor	EGF	G
Epidermal growth factor receptor	EGFR	G
Epilepsy, benign neonatal 4 gene	ICCA	E
Epilepsy, female restricted	EFMR	E
Epilepsy, progressive myoclonic 2 gene	EPM2A	E
Erythrocyte membrane protein band 4.1	EPB41	S
Erythrocyte membrane protein band 4.2	EPB42	S
Erythrocyte membrane protein band 7.2	EPB72	S
Erythroid kruppel-like factor	EKLF	G
Erythropoietin	EPO	I
Erythropoietin receptor	EPOR	I
Estrogen receptor	ESR	G
Eukaryotic initiation translation factor	EIF4E	G
EWS RNA-binding protein	EWSR1	G
Excision repair complementation group 1 protein	ERCC1	E
Excision repair complementation group 2 protein	ERCC2	E
Excision repair complementation group 2 protein	ERCC3	E
Excision repair complementation group 4 protein	ERCC4	E
Excision repair complementation group 6 protein	ERCC6	E
Exostosin 1	EXT1	S



Exostosin 2	EXT2	S
Exostosin 3	EXT3	S
Eyes absent 1	EYA1	G
Eyes absent 2	EYA2	G
Eyes absent 3	EYA3	G
Faciogenital dysplasia	FGD1, FGDY	T
Factor 1 (No. one)	F1	I
Factor B, properdin		I
Factor D		I
Factor H	HF1	I
Factor I (letter I)	IF	I
Factor III	F3	I
Factor IX	F9	I
Factor V	F5	I
Factor VII	F7	I
Factor VIII	F8	I
Factor X	F10	I
Factor XI	F11	I
Factor XII	F12	I
Factor XIII A & B	F13A & F13B	I
Fanconi anemia, complementation group A	FANCA	T
Fanconi anemia, complementation group C	FANCC	T
Fanconi anemia, complementation group D	FANCD	T
Fc fragment of IgG, high affinity IA, receptor for	FCGR1A	G
Fc fragment of IgG, low affinity IIa, receptor for	FCGR2A	G
(CD32)		
Fc fragment of IgG, low affinity IIIa, receptor for	FCGR3A	G
(CD16)		
Fc receptor		I
Fertilin protein	FTNB	G
Fibrillin 1	FBN1	G
Fibrillin 2	FBN2	G
Fibroblast growth factor	FGF1	G
Fibroblast growth factor receptor 1	FGFR1	G
Fibroblast growth factor receptor 2	FGFR2	G
Fibroblast growth factor receptor 3	FGFR3	G
Fibronectin precursor	FN1	G
Flavin-containing monooxygenase 1	FMO1	E
Flavin-containing monooxygenase 2	FMO2	E
Flavin-containing monooxygenase 3	FMO3	E
Flavin-containing monooxygenase 4	FMO4	E
Flightless-II, Drosophila homolog of	FLII	G
Folic acid receptor	FOLR	G
Follicle stimulating hormone receptor	FSHR, ODG1	G
Follicle stimulating hormone, FSH	FSHB	G
Follicular lymphoma variant translocation 1	FVT1	I
Follistatin		G
Forkhead rhabdomyosarcoma gene	FKHR	G

Forkhead transcription factor 10	FKHL10	G
Forkhead transcription factor 14	FKHL14	G
Forkhead transcription factor 7	FKHL7	G
Formiminotransferase		E
Fragile site, folic acid type, rare, fra(X) A	FRAXA	N
Fragile site, folic acid type, rare, fra(X) E	FRAXE	N
Fragile site, folic acid type, rare, fra(X) F	FRAXF	N
Frataxin	FRDA	G
Fringe secreted protein, lunatic	LFNG	G
Fringe secreted protein, manic	MFNG	G
Fringe secreted protein, radical	RFNG	G
Fructose-1,6-diphosphatase	FBP1	E
Fucosyltransferase 6	FUT6	T
Fukuyama type congenital muscular dystrophy	FCMD	G
Fumarase	FH	E
Fumarylacetoacetase	FAH	E
G/T mismatch binding protein	GTBP, MSH6	G
GABA receptor, alpha 1	GABRA1	N
GABA receptor, alpha 2	GABRA2	N
GABA receptor, alpha 3	GABRA3	N
GABA receptor, alpha 4	GABRA4	N
GABA receptor, alpha 5	GABRA5	N
GABA receptor, alpha 6	GABRA6	N
GABA receptor, beta 1	GABRB1	N
GABA receptor, beta 2	GABRB2	N
GABA receptor, beta 3	GABRB3	N
GABA receptor, gamma 1	GABRG1	N
GABA receptor, gamma 2	GABRG2	N
GABA receptor, gamma 3	GABRG3	N
GABA transaminase	ABAT	E
Gadd45 (growth arrest & DNA-damage-inducible protein)		E
Galactocerebrosidase	GALC	E
Galactokinase	GALK1	E
Galactose 1-phosphate uridyl-transferase	GALT	E
Galactosyltransferase 1	GT1	G
Galactosyltransferase, alpha 1,3	GGTA1	G
Galactosyltransferase, beta 3	B3GALT	G
Galanin	GAL	N
Galanin receptor	GALNR1	N
Gamma-glutamyl carboxylase	GGCX	T
Gap junction protein alpha 1	GJA1	T
Gap junction protein alpha 3	GJA3	T
Gap junction protein alpha 8	GJA8	T
Gap junction protein beta 1	GJB1	T
Gap junction protein beta 2	GJB2	T
Gap junction protein beta 3	GJB3	T
Gastric Intrinsic factor, GIF	GIF	E
Gastrin	GAS	G

Gastrin releasing peptide	GRP	T
Gastrointestinal tumor-associated antigen 1	GA733	I
Gastrulation brain homeobox 2	GBX2	G
GDP dissociation inhibitor 1	GDI1	G
Gelsolin	GSN	G
Geniospasm 1	GSM1	G
Gephyrin		N
Glial-cell derived neurotrophic factor (GDNF) receptor		N
Glial-cell derived neurotrophic factor, GDNF	GDNF	N
Glioma chloride ion channel, GCC		G
Glucagon receptor	GCGR	G
Glucagon-like peptide receptor 1	GLP1R	G
Glucocorticoid receptor	GRL	G
Glucose-6-phosphatase translocase	G6PT1	E
Glucosidase, acid alpha	GAA	E
Glucosidase, acid beta	GBA	E
Glutamate decarboxylase, GAD	GAD1	E
Glutamate-cysteine ligase	GLCLC	E
Glutathione	GSH	T
Glutathione peroxidase, GPX1	GPX1	E
Glutathione peroxidase, GPX2	GPX2	E
Glutathione reductase, GSR	GSR	E
Glutathione S-transferase mu 1, GSTM1	GSTM1	E
Glutathione S-transferase mu 4, GSTM4		E
Glutathione S-transferase theta 1, GSTT1	GSTT1	E
Glutathione S-transferase theta 2, GSTT2		E
Glutathione S-transferase, GSTP1	GSTP1	E
Glutathione S-transferase, GSTZ1	GSTZ1	E
Glutathione synthetase	GSS	E
Glyceraldehyde-3-phosphate dehydrogenase, GAPDH	GAPDH	E
Glycerol kinase	GK	E
Glycinamide ribonucleotide (GAR) transformylase	GART	E
Glycine dehydrogenase	GLDC	E
Glycine receptor, alpha	GLRA2	N
Glycine receptor, beta		N
Glycogen branching enzyme	GBE1	E
Glycogen phosphorylase	PYGL	E
Glycogen synthase 1 (muscle)	GLYS1	E
Glycogen synthase 2 (liver)	GYS2	E
Glycosyltransferases, ABO blood group	ABO	E
Glypican 3	GPC3, SDYS	G
GM2 ganglioside activator protein, GM2A	GM2A	E
Gonadotropin releasing hormone	GNRH	G
Gonadotropin releasing hormone receptor	GNRHR	G
Goosecoid GSC		G

Green cone pigment	GCP	S
Growth arrest-specific homeobox	GAX	G
Growth factor receptor-bound protein 2	GRB2	G
Growth hormone 1	GH1	G
Growth hormone 2 (placental)	GH2	G
Growth hormone receptor	GHR	G
Growth hormone releasing hormone (GHRH)	GHRH	G
Growth hormone releasing hormone receptor	GHRHR	G
Growth/differentiation factor 5	GDF5	G
Growth-regulated protein precursor, GRO	GRO	I
GTP cyclohydrolase 1	GCH1	G
GTPase-activating protein, GAP	RASA1	G
Guanidinoacetate N-methyltransferase	GAMT	E
Guanine nucleotide-binding protein, alpha activating activity polypeptide, GNAO	GNAO1	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 1, GNAI1	GNAI1	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 2, GNAI2	GNAI2	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 3, GNAI3	GNAI3	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS1	GNAS1	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS2	GNAS2	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS3	GNAS3	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS4	GNAS4	N
Guanine nucleotide-binding protein, alpha transducing activity polypeptide, GNAT1	GNAT1	N
Guanine nucleotide-binding protein, alpha transducing activity polypeptide, GNAT2	GNAT2	N
Guanine nucleotide-binding protein, beta polypeptide 3	GNB3	N
Guanine nucleotide-binding protein, gamma polypeptide 5	GNG5	N
Guanine nucleotide-binding protein, q polypeptide	GNAQ	N
Guanylate cyclase 2D, membrane (retina-specific)	GUCY2D	E
Guanylate cyclase activator 1A (retina)	GUCA1A	E
Guanylate kinase		E
Gustducin, alpha (taste-specific G protein)	GDCA	N
Haeme regulated inhibitor kinase		E
Haemoglobin epsilon		T
Hairless	HR	G
Haptoglobin, alpha 1	HPA1	I

Haptoglobin, alpha 2	HPA2	I
Haptoglobin, beta	HPB	I
Heat shock protein, HSP60		I
Heat shock protein, HSP70		I
Heat shock protein, HSP90		I
Heat shock protein, HSPA1		I
Heat shock protein, HSPA2		I
Hela tumor suppression gene	HTS1	G
Hemochromatosis	HFE	T
Hemopexin	HPX	I
Heparan sulfamidase		E
Heparin binding epidermal growth factor	HBEGF	G
Hepatic nuclear factor-3-beta	HNF3B	E
Hepatic nuclear factor-4-alpha	HNF4A	E
Hepatitis B virus integration site 1	HVBS1	I
Hepatitis B virus integration site 2	HVBS6	I
Hepatocyte growth factor	HGF	G
Hexosaminidase A	HEXA,TSD	E
Hexosaminidase B	HEXB	E
High mobility group protein 1	HMG1	G
High mobility group protein 2	HMG2	G
High mobility group protein C	HMGIC	G
High mobility group protein Y	HMG1Y	G
Histone family H1	H1	G
Histone family H2	H2	G
Histone family H3	H3	G
Histone family H4	H4	G
HLA-B associated transcript 1	BAT1	I
HLH transcription factor HAND1	HAND1	G
HLH transcription factor HAND2	HAND2	G
HMG-CoA lyase	HMGCL	E
HMG-CoA reductase	HMGCR	E
HMG-CoA synthase	HMGCS2	E
Holocarboxylase synthetase	HLCS	E
Holoprosencephaly 1	HPE1	G
Holoprosencephaly 2	HPE2	G
Holoprosencephaly 3	HPE3	G
Holoprosencephaly 4	HPE4	G
Homeobox (HOX) gene A1	HOXA1	G
Homeobox (HOX) gene A10	HOXA10	G
Homeobox (HOX) gene A11	HOXA11	G
Homeobox (HOX) gene A12	HOXA12	G
Homeobox (HOX) gene A13	HOXA13	G
Homeobox (HOX) gene A2	HOXA2	G
Homeobox (HOX) gene A3	HOXA3	G
Homeobox (HOX) gene A4	HOXA4	G
Homeobox (HOX) gene A5	HOXA5	G
Homeobox (HOX) gene A6	HOXA6	G

Homeobox (HOX) gene A7	HOXA7	G
Homeobox (HOX) gene A8	HOXA8	G
Homeobox (HOX) gene A9	HOXA9	G
Homeobox (HOX) gene B1	HOXB1	G
Homeobox (HOX) gene B2	HOXB2	G
Homeobox (HOX) gene B3	HOXB3	G
Homeobox (HOX) gene B4	HOXB4	G
Homeobox (HOX) gene B5	HOXB5	G
Homeobox (HOX) gene B6	HOXB6	G
Homeobox (HOX) gene B7	HOXB7	G
Homeobox (HOX) gene B8	HOXB8	G
Homeobox (HOX) gene B9	HOXB9	G
Homeobox (HOX) gene C13	HOXC13	G
Homeobox (HOX) gene C4	HOXC4	G
Homeobox (HOX) gene C8	HOXC8	G
Homeobox (HOX) gene C9	HOXC9	G
Homeobox (HOX) gene D1	HOXD1	G
Homeobox (HOX) gene D10	HOXD10	G
Homeobox (HOX) gene D12	HOXD12	G
Homeobox (HOX) gene D13	HOXD13	G
Homeobox (HOX) gene D3	HOXD3	G
Homeobox (HOX) gene D4	HOXD4	G
Homeobox (HOX) gene D8	HOXD8	G
Homeobox (HOX) gene D9	HOXD9	G
Homeobox 11	HOX11	G
Homeobox HB24	HLX1	G
Homeobox HB9	HLXB9	G
Homeobox, PROX1	PROX1	G
HSSB, replication protein		E
Human atonal gene	ATOH1	G
Human chorionic gonadotrophin, hCG	CG	G
Human placental lactogen	CSH1	G
Huntingtin	HD	T
Hypoxanthine-guanine phosphoribosyltransferase, HGPRT	HPRT	E
Hypoxia inducible factor 1	HIF1A	E
Hypoxia inducible factor 2		E
IC7 A and B		I
Iduronate 2 sulphatase	IDS	E
Ikaros gene	IKAROS	G
Immunoglobulin alpha (IgA)	IGHA	I
Immunoglobulin delta (IgD)	IGHD	I
Immunoglobulin E (IgE) responsiveness gene	IGER	I
Immunoglobulin E (IgE) serum concentration regulator gene	IGES	I
Immunoglobulin epsilon (IgE)	IGHE	I
Immunoglobulin gamma (IgG) 2	IGHG2	I
Immunoglobulin heavy mu chain	IGHM	I

Immunoglobulin J polypeptide	IGJ	I
Immunoglobulin kappa constant region	IGKC	I
Immunoglobulin kappa variable region	IGKV	I
Indian hedgehog, ihh	IHH	G
Inhibin, alpha	INHA	G
Inhibin, beta A	INHBA	G
Inhibin, beta B	INHBB	G
Inhibin, beta C	INHBC	G
Inosine monophosphate dehydrogenase, IMPDH		E
Inositol 1,4,5-triphosphate receptor 1	ITPR1	G
Inositol 1,4,5-triphosphate receptor 3	ITPR3	G
Insulin	INS	G
Insulin promotor factor 1	IPF1	G
Insulin receptor	INSR	G
Insulin receptor substrate-1	IRS1	G
Insulin-like growth factor 1	IGF1	G
Insulin-like growth factor 1 receptor	IGF1R	G
Insulin-like growth factor 2	IGF2	G
Insulin-like growth factor 2 receptor	IGF2R	G
Integrin beta 1	ITGB1	G
Integrin beta 2	ITGB2	G
Integrin beta 3	ITGB3	G
Integrin beta 4	ITGB4	G
Integrin beta 5	ITGB5	G
Integrin beta 6	ITGB6	G
Integrin beta 7	ITGB7	G
Integrin, alpha 1	ITGA1	G
Integrin, alpha 2	ITGA2	G
Integrin, alpha 3	ITGA3	G
Integrin, alpha 4	ITGA4	G
Integrin, alpha 5	ITGA5	G
Integrin, alpha 6	ITGA6	G
Integrin, alpha 7	ITGA7	G
Integrin, alpha 8	ITGA8	G
Integrin, alpha 9	ITGA9	G
Integrin, alpha M	ITGAM	G
Integrin, alpha X	ITGAX	G
Inter-alpha-trypsin inhibitor, IATI		E
Intercellular adhesion molecule 1	ICAM1	I
Intercellular adhesion molecule 2	ICAM2	I
Intercellular adhesion molecule 3	ICAM3	I
Interferon alpha	IFNA1	I
Interferon beta	IFNB	I
Interferon gamma	IFNG	I
Interferon gamma receptor 1	IFNGR1	I
Interferon gamma receptor 2	IFNGR2	I
Interferon regulatory factor 1	IRF1	I

Interferon regulatory factor 4	IRF4	I
Interleukin(IL) 1 receptor	IL1R	I
Interleukin(IL) 1, alpha	IL1A	I
Interleukin(IL) 1, beta	IL1B	I
Interleukin(IL) 10	IL10	I
Interleukin(IL) 10 receptor	IL10R	I
Interleukin(IL) 11	IL11	I
Interleukin(IL) 11 receptor	IL11R	I
Interleukin(IL) 12	IL12	I
Interleukin(IL) 12 receptor, beta 1	IL12RB1	I
Interleukin(IL) 13	IL13	I
Interleukin(IL) 13 receptor	IL13R	I
Interleukin(IL) 2	IL2	I
Interleukin(IL) 2 receptor, alpha	IL2RA	I
Interleukin(IL) 2 receptor, gamma	IL2RG	I
Interleukin(IL) 3	IL3	I
Interleukin(IL) 3 receptor	IL3R	I
Interleukin(IL) 4	IL4	I
Interleukin(IL) 4 receptor	IL4R	I
Interleukin(IL) 5	IL5	I
Interleukin(IL) 5 receptor	IL5R	I
Interleukin(IL) 6	IL6	I
Interleukin(IL) 6 receptor	IL6R	I
Interleukin(IL) 7	IL7	I
Interleukin(IL) 7 receptor	IL7R	I
Interleukin(IL) 8	IL8	I
Interleukin(IL) 8 receptor	IL8R	I
Interleukin(IL) 9	IL9	I
Interleukin(IL) 9 receptor	IL9R	I
Interleukin(IL) receptor antagonist 1	IL1RN, IL1RA	I
IP3 kinase		E
Isocitrate dehydrogenase		E
Isovaleric acid CoA dehydrogenase	IVD	E
Janus kinase 1	JAK1	G
Janus kinase 2	JAK2	G
Janus kinase 3	JAK3	G
Kallman syndrome gene 1	KAL1	G
Kell blood group precursor	XK, KEL	T
Keratin 1	KRT1	S
Keratin 10	KRT10	S
Keratin 11	KRT11	S
Keratin 12	KRT12	S
Keratin 13	KRT13	S
Keratin 14	KRT14	S
Keratin 15	KRT15	S
Keratin 16	KRT16	S
Keratin 17	KRT17,PCHC1	S
Keratin 18	KRT18	S



Keratin 2	KRT2	S
Keratin 3	KRT3	S
Keratin 4	KRT4	S
Keratin 5	KRT5	S
Keratin 6	KRT6	S
Keratin 7	KRT7	S
Keratin 8	KRT8	S
Keratin 9	KRT9	S
Ketohexokinase	KHK	E
Kinectin	KTN1	G
Kinesin, heavy chain	KNSL1	G
Kinesin, light chain	KNS2	G
L1 cell adhesion molecule	L1CAM	N
Lactotransferrin	LTF	T
Lamin A/C	LMNA	G
Laminin 5, alpha 3	LAMA3	G
Laminin 5, beta 3	LAMB3	G
Laminin 5, gamma 2	LAMC2	G
Laminin M	LAMM	G
Laminin receptor 1	LAMR1	G
Latent transforming growth factor-beta binding protein 2	LTBP2	G
Leptin	LEP	G
Leptin receptor	LEPR	G
Leukaemia inhibitory factor	LIF	G
Leukaemia inhibitory factor receptor	LIFR	G
Leukin		I
Leukocyte-specific transcript 1	LST-1	I
Leukotriene A4 hydrolase		I
Leukotriene A4 synthase	LTA4S	E
Leukotriene B4 receptor		I
Leukotriene B4 synthase	LTB4S	E
Leukotriene C4 receptor		I
Leukotriene C4 synthase	LTC4S	E
Leukotriene D4/E4 receptor		I
LH/choriogonadotropin (CG) receptor	LHCGR	G
LIM homeobox protein 1	LHX1	G
LIM homeobox protein 2	LHX2	G
LIM homeobox protein 3	LHX3	G
LIM homeobox protein 4	LHX4	G
LIM homeobox transcription factor 1, beta	LMX1B	G
Limb girdle muscular dystrophy 1A	LGMD1A	G
Limb girdle muscular dystrophy 1B	LGMD1B	G
Limb girdle muscular dystrophy 2G	LGMD2G	G
Limb girdle muscular dystrophy 2H	LGMD2H	G
Limbic associated membrane protein	LAMP	G
LIM-domain only protein 1	LMO1	G
LIM-domain only protein 2	LMO2	G

LIM-domain only protein 3	LMO3	G
LIM-domain only protein 4	LMO4	G
Lipoma-preferred partner gene	LPP	G
Lipoprotein receptor, Low Density	LDLR	T
Lipoxygenase 12 (platelets)	LOG12	I
Lipoxygenase 5 (leukocytes)		I
Long QT-type 2 potassium channels	LQT2, KCNH2	T
Loricrin	LOR	S
Low density lipoprotein receptor-related protein precursor	LRP	T
Luteinizing hormone, beta chain	LHB	G
Lymphoblastic leukemia derived sequence 1	LYL1	I
Lymphocyte-specific protein tyrosine kinase	LCK	I
Lymphoid enhancer-binding factor	LEF-1	G
Lysosome-associated membrane protein 1	LAMP1	G
Lysosome-associated membrane protein 2	LAMP2	G
MAD (mothers against decapentaplegic, Drosophila) homologue 2	MADH2	G
MAD (mothers against decapentaplegic, Drosophila) homologue 3	MADH3	G
MAD (mothers against decapentaplegic, Drosophila) homologue 4	MADH4	G
MADS box transcription-enhancer factor 2A	MEF2A	G
MADS box transcription-enhancer factor 2B	MEF2B	G
MADS box transcription-enhancer factor 2C	MEF2C	G
MADS box transcription-enhancer factor 2D	MEF2D	G
Malate dehydrogenase, mitochondrial	MDH2	E
Malignant proliferation, eosinophil gene	MPE	I
Malonyl CoA decarboxylase		E
Malonyl CoA transferase		E
Mannosidase, alpha B lysosomal	MANB	E
Mannosidase, beta A lysosomal	MANBA	E
MAPK kinase 1	MAPKK1; MEK1	G
MAPK kinase 4	MAPKK4; MEK4; SERK1	G
MAPK kinase 6	MAPKK6; MEK6	G
MAPKK kinase	MAPKKK	G
Matrix Gla protein	MGP	G
Matrix metalloproteinase 1	MMP1	E
Matrix metalloproteinase 10	MMP10	E
Matrix metalloproteinase 11	MMP11	E
Matrix metalloproteinase 12	MMP12	E
Matrix metalloproteinase 13	MMP13	E
Matrix metalloproteinase 14	MMP14	E
Matrix metalloproteinase 15	MMP15	E
Matrix metalloproteinase 16	MMP16	E
Matrix metalloproteinase 17	MMP17	E
Matrix metalloproteinase 18	MMP18	E

Matrix metalloproteinase 19	MMP19	E
Matrix metalloproteinase 2	MMP2	E
Matrix metalloproteinase 3	MMP3, STMY1	E
Matrix metalloproteinase 4	MMP4	E
Matrix metalloproteinase 5	MMP5	E
Matrix metalloproteinase 6	MMP6	E
Matrix metalloproteinase 7	MMP7	E
Matrix metalloproteinase 8	MMP8	E
Matrix metalloproteinase 9	MMP9	E
MAX-interacting protein 1	MXI1	G
MEK kinase, MEKK		E
Melanocortin 1 receptor	MC1R	T
Melanocortin 2 receptor	MC2R	T
Melanocortin 4 receptor	MC4R	T
Menin	MEN1	G
Mesoderm-specific transcript	MEST	G
Methionine adenosyltransferase	MAT1A, MAT2A	E
Methionine synthase	MTR	E
Methionine synthase reductase	MTRR	E
Methylguanine-DNA methyltransferase	MGMT	E
Methylmalonyl-CoA mutase	MUT	E
Mevalonate kinase	MVK	E
MHC Class I: A		I
MHC Class I: B		I
MHC Class I: C		I
MHC Class I: LMP-2, LMP-7		I
MHC Class I: Tap1	ABCR, TAP1	I
MHC Class II: DP	HLA-DPB1	I
MHC Class II: DQ		I
MHC Class II: DR		I
MHC Class II: Tap2	TAP2, PSF2	I
MHC Class II:Complementation group A	MHC2TA	I
MHC Class II:Complementation group B	rfxank	I
MHC Class II:Complementation group C	RFX5	I
MHC Class II:Complementation group D	RFXAP	I
Microphthalmia-associated transcription factor	MITF	G
Microsomal triglyceride transfer protein	MTP	T
Microtubule associated protein	MAP	S
Midline 1	MID1	G
Mismatch repair gene, PMSL1	PMS1	G
Mismatch repair gene, PMSL2	PMS2	G
Mitochondrial trifunctional protein, alpha subunit	HADHA	E
Mitochondrial trifunctional protein, beta subunit	HADHB	E
Mitogen-activated protein (MAP) kinase	MAPK	G
Molybdenum cofactor synthesis 1	MOCS1	E
Molybdenum cofactor synthesis 2	MOCS2	E
Monoamine oxidase A	MAOA	E

Monoamine oxidase B	MAOB	E
Monocyte chemoattractant protein 1	MCP1	I
Motilin	MLN	G
Msh homeobox homolog 1	MSX1	G
Msh homeobox homolog 2	MSX2	G
Mucopolidoses	GNPTA	E
Mulibrey nanism	MUL	T
Multidrug resistance associated protein	MRP	G
Muscarinic receptor, M1	CHRM1	N
Muscarinic receptor, M2	CHRM2	N
Muscarinic receptor, M3	CHRM3	N
Muscarinic receptor, M4	CHRM4	N
Muscarinic receptor, M5	CHRM5	N
Muscle phosphorylase	PYGM	E
Mutated in colorectal cancers, MCC	MCC	G
MutL homolog 1	MLH1	G
MutS homolog 2	MSH2	G
MutS homolog 3	MSH3	G
Myelin protein peripheral 22	PMP22	S
Myelin protein zero	MPZ	S
Myelodysplasia syndrome 1 gene	MDS1	G
Myeloid leukemia factor-1	MLF1	I
Myocilin	MYOC	T
Myogenic factor 3	MYF3	G
Myogenic factor 4	MYF4	G
Myogenic factor 5	MYF5	G
Myomesin 1	MYOM1	S
Myomesin 2	MYOM2	S
Myosin 15	MYO15	S
Myosin 6	MYO6	S
Myosin 7A	MYO7A	S
Myosin, cardiac	MYH7	S
Myotubularin	MTM1	S
Na <sup>+</sup> , K <sup>+</sup> ATPase, alpha	ATP1A1	G
Na <sup>+</sup> , K <sup>+</sup> ATPase, beta 1	ATP1B1	G
Na <sup>+</sup> , K <sup>+</sup> ATPase, beta 2	ATP1B2	G
Na <sup>+</sup> , K <sup>+</sup> ATPase, beta 3	ATP1B3	G
Na <sup>+</sup> /H <sup>+</sup> exchanger 1	NHE1	T
Na <sup>+</sup> /H <sup>+</sup> exchanger 2	NHE2	T
Na <sup>+</sup> /H <sup>+</sup> exchanger 3	NHE3	T
Na <sup>+</sup> /H <sup>+</sup> exchanger 4	NHE4	T
Na <sup>+</sup> /H <sup>+</sup> exchanger 5	NHE5	T
N-acetylgalactosamine-6-sulfate sulfatase	GALNS	E
N-acetylglucosamine-6-sulfatase	GNS	E
N-acetylglucosaminidase, alpha	NAGLU	E
N-acetyltransferase 1	NAT1	E
N-acetyltransferase 2	NAT2	E
NADH dehydrogenase		E

NADH dehydrogenase (ubiquinone) Fe-S protein 1	NDUFS1	E
NADH dehydrogenase (ubiquinone) Fe-S protein 4	NDUFS4	E
NADH dehydrogenase (ubiquinone) flavoprotein 1	NDUFV1	E
NADH-cytochrome b5 reductase	DIA1	E
NADPH-dependent cytochrome P450 reductase	POR	E
Natural resistance-associated macrophage protein 1	NRAMP1	I
NB6		I
Necdin	NDN	G
Nephronophthisis 1	NPHP1	T
Nephronophthisis 2	NPHP2	T
Nephrosis 1	NPHS1	T
Nerve growth factor	NGF	G
Nerve growth factor receptor	NGFR	G
Neural retina-specific gene	NRL	G
Neuraminidase sialidase	NEU	T
Neuregulin	HGL	G
Neurite growth-promoting factor 2	MDK	N
Neurite inhibitory protein		N
Neuroendocrine convertase 1	NEC1, PCSK1	E
Neurofibromin 1	NF1	G
Neurofibromin 2	NF2	G
Neurofilament protein, heavy	NFH	S
Neurofilament protein, NF125	NF150	S
Neurofilament protein, NF200	NF200	S
Neurofilament protein, NF68	NF68	S
Neuronal apoptosis inhibitory protein	NAIP	I
Neuronal molecule-1		I
Neuronal molecule-1 receptor		I
Neuropeptide Y	NPY	N
Neuropeptide Y receptor Y1	NPY1R	N
Neuropeptide Y receptor Y2	NPY2R	N
Neurotrophic tyrosine kinase receptor 1	NTRK1	G
Neurotrophin 3	NTF3 or NT3	G
Neurturin	NRTN	G
Neutral endopeptidase		E
Neutrophil cystolic factor 1	NCF1	I
Neutrophil cystolic factor 2	NCF2	I
Niacin receptor		G
Nibrin	NBS1	G
Nitric oxide synthase 1, NOS1	NOS1	E
Nitric oxide synthase 2, NOS2	NOS2	E
Nitric oxide synthase 3, NOS3	NOS3	E
Nodal	NODAL	G

Noggin	NOG	G
Norrie disease protein	NDP	G
Notch 1	NOTCH1	G
Notch 2	NOTCH2	G
Notch 3	NOTCH3	G
Notch ligand - jagged 1	JAG1, AGS	G
Nuclear factor I-kappa-B-like gene	IKBL	I
Nuclear factor kappa beta	NFKB	I
Nuclear factor of activated T cells (NFAT) complex, cytosolic	NFATC	G
Nuclear factor of activated T cells (NFAT) complex, preexisting component	NFATP	G
Nuclear mitotic apparatus protein 1	NUMA1	G
Nucleophosmin	NPM1	T
Nucleoside diphosphate kinase-A	NDPKA	E
Ocular albinism 1	OA1	S
Oculocutaneous albinism II	OCA2	S
Oligophrenin-1	OPHN1	G
Oncogene abl1	ABL1	G
Oncogene abl2		G
Oncogene akt1		G
Oncogene akt2	AKT2	G
Oncogene axl	AXL	G
Oncogene bcl2		G
Oncogene bcr/abl		G
Oncogene B-lym		G
Oncogene B-raf		G
Oncogene clk1		G
Oncogene c-myc		G
Oncogene cot		G
Oncogene crk		G
Oncogene crkl		G
Oncogene ect2		G
Oncogene ELK1	ELK1	G
Oncogene ELK2	ELK2	G
Oncogene ems1		G
Oncogene ERB		G
Oncogene ERB2		G
Oncogene ERBA		G
Oncogene ERBAL2		G
Oncogene ERG (early reponse gene)		G
Oncogene ETS1		G
Oncogene ETS2		G
Oncogene EVI1	EVI1	G
Oncogene fes		G
Oncogene fgr		G
Oncogene fos	FOS	G
Oncogene fps		G

Oncogene GLI1	GLI	G
Oncogene GLI2	GLI2	G
Oncogene GLI3	GLI3	G
Oncogene gro1		G
Oncogene gro2		G
Oncogene Ha-ras	HRAS	G
Oncogene hs1		G
Oncogene hst	FGF4	G
Oncogene int1	WNT1	G
Oncogene int2	FGF3	G
Oncogene int3	Notch4	G
Oncogene int4	WNT3	G
Oncogene jun	JUN	G
Oncogene KIT	KIT, PBT	G
Oncogene LCO	LCO	G
Oncogene l-myc		G
Oncogene lpsa		G
Oncogene lyn		G
Oncogene maf		G
Oncogene mas1		G
Oncogene mcf2		G
Oncogene mdm2	MDM2	G
Oncogene mel		G
Oncogene met	MET	G
Oncogene mos		G
Oncogene mpl		G
Oncogene MUM1	MUM1	G
Oncogene myb	MYB	G
Oncogene myc	MYC	G
Oncogene n-myc		G
Oncogene N-ras (neuroblastoma v-ras)	NRAS	G
Oncogene ovc		G
Oncogene pim1		G
Oncogene pti-1sea		G
Oncogene pvt1		G
Oncogene raf	RAF	G
Oncogene ralb		G
Oncogene rel		G
Oncogene ret	RET	G
Oncogene r-myc		G
Oncogene ros		G
Oncogene R-ras		G
Oncogene sis	PDGFB	G
Oncogene ski		G
Oncogene sno		G
Oncogene spi1		G
Oncogene src		G
Oncogene tc21		G

Oncogene TEL	ETV6	G
Oncogene tim		G
Oncogene vavtrk		G
Oncogene v-Ki-ras2	KRAS2	G
Oncogene yes		G
Oncogene yuasa		G
Oncostatin M	OSM	G
Oncostatin M receptor	OSMR	G
Orexin	OX	G
Orexin 1 receptor	OX1R	G
Orexin 2 receptor	OX2R	G
Ornithine delta-aminotransferase	OAT	E
Ornithine transcarbamoylase	OTC, NME1	E
Orthodenticle (Drosophila) homolog 1	OTX1	G
Orthodenticle (Drosophila) homolog 2	OTX2	G
Osteocalcin		S
Osteonectin	ON	G
Osteopontin	OPN	G
Osteoprotegerin	OPG	G
Otoferlin	OTOF	N
Oxytocin	OXT	N
Oxytocin receptor	OXTR	N
p21-activated kinase 3	PAK3	G
Paired box homeotic gene 1	PAX1	G
Paired box homeotic gene 2	PAX2	G
Paired box homeotic gene 3	PAX3	G
Paired box homeotic gene 6	PAX6	G
Paired box homeotic gene 7	PAX7	G
Paired box homeotic gene 8	PAX8	G
Paired-like homeodomain transcription factor 2	PITX2	G
Paired-like homeodomain transcription factor 3	PITX3	G
Palmitoyl-protein thioesterase	PPT	T
Pancreatic amylase		E
Parathyroid hormone	PTH	G
Parathyroid hormone receptor	PTHr1	G
Parathyroid hormone related-peptide	PTHrP	G
Parathyroid hormone-like hormone	PTHLH	G
Parvalbumin	PVALB	G
Patched (Drosophila) homolog, PTCH	PTCH	G
PCNA (proliferating cell nuclear antigen)		E
Peanut-like 1	PNUTL1	I
Pendrin, PDS	PDS	T
Peptidylglycine alpha-amidating monooxygenase	PAM	E
Peripherin, PRPH		S
Peroxisomal membrane protein 1	PXMP1	S
Peroxisomal membrane protein 3	PXMP3	T
Peroxisome biogenesis factor 1	PEX1	T



Peroxisome biogenesis factor 19	PEX19	T
Peroxisome biogenesis factor 6	PEX6	T
Peroxisome biogenesis factor 7	PEX7	T
Peroxisome proliferative activated receptor, alpha	PPARA	T
Peroxisome proliferative activated receptor, gamma	PPARG	T
Peroxisome receptor 1	PXR1	T
Phenylethanolamine N-methyltransferase, PNMT	PNMT	E
Phosphatase & tensin homolog	PTEN	G
Phosphate regulating gene with homologies to endopeptidases on the X chromosome	PHEX	G
Phosphatidylinositol glycan, class A (paroxysmal nocturnal hemoglobinuria)	PIGA	G
Phosphatidylinositol transfer protein	PITPN	G
Phosphodiesterase 1 / nucleotide pyrophosphatase 1	PDNP1	G
Phosphodiesterase 1 / nucleotide pyrophosphatase 2	PDNP2	G
Phosphodiesterase 1 / nucleotide pyrophosphatase 3	PDNP3	G
Phosphofructokinase, liver	PFKL	E
Phosphofructokinase, muscle	PFKM	E
Phosphoglucose isomerase	GPI	E
Phosphoglycerate kinase 1	PGK1	E
Phosphoglycerate mutase 2	PGAM2	E
Phospholipase A2, group 10	PLA2G10	I
Phospholipase A2, group 1B	PLA2G1B	I
Phospholipase A2, group 2A	PLA2G2A	I
Phospholipase A2, group 2B	PLA2G2B	I
Phospholipase A2, group 4A	PLA2G4A	I
Phospholipase A2, group 4C	PLA2G4C	I
Phospholipase A2, group 5	PLA2G5	I
Phospholipase A2, group 6	PLA2G6	I
Phospholipase C alpha		I
Phospholipase C beta		I
Phospholipase C delta	PLCD1	I
Phospholipase C epsilon		I
Phospholipase C gamma	PLCG1	I
Phosphomannomutase 1	PMM1	G
Phosphomannomutase 2	PMM2	G
Phosphomannomutase-2	PMM2	T
Phosphorylase kinase deficiency, liver	PHK	E
Phosphorylase kinase, alpha 2	PHKA2	E
Phytanoyl-CoA hydroxylase	PHYH	G
Plakophilin 1	PKP1	T
Plasminogen	PLG	E

Plasminogen activator inhibitor 1	PAI1	E
Plasminogen activator inhibitor 2	PAI2	E
Plasminogen activator receptor, Urokinase	UPAR; PLAUR	S
Plasminogen activator, Tissue	PLAT; TPA	E
Plasminogen activator, Urokinase	UPA; PLAU	E
Platelet derived growth factor	PDGF	G
Platelet derived growth factor receptor	PDGFR	G
Plectin 1	PLEC1	T
Poly (ADP-ribose) synthetase	PARS	E
Poly(A) binding protein 2	PABP2	G
Postsynaptic density-95 protein	PSD95	N
Potassium inwardly-rectifying channel J1	KCNJ1	N
Potassium inwardly-rectifying channel J11	KCNJ11	N
Potassium voltage-gated channel A1	KCNA1	N
Potassium voltage-gated channel E1	KCNE1	N
Potassium voltage-gated channel Q1	KCNQ1	N
Potassium voltage-gated channel Q2	KCNQ2	N
Potassium voltage-gated channel Q3	KCNQ3	N
Potassium voltage-gated channel Q4	KCNQ4	N
POU domain, class 1, transcription factor 1 (Pit1)	POU1F1	G
POU domain, class 3, transcription factor 4	POU3F4	G
POU domain, class 4, transcription factor 3	POU4F3	G
Pre-B-cell leukemia transcription factor 1	PBX1	G
Preproglucagon	GCG;GLP1; GLP2	G
Procollagen N-protease		E
Procollagen peptidase		E
Profibrinolysin		G
Progesterone receptor (RU486 binding receptor)	PGR	G
Prohibitin	PHB	G
Prolactin	PRL	G
Prolactin receptor	PRLR	G
Prolactin releasing hormone	PRH	G
Proliferin	PLF	G
Proline dehydrogenase	PRODH	E
Pro-melanin-concentrating hormone	PMCH	G
Promyelocytic leukemia gene	PML	G
Proopiomelanocortin	POMC	N
Prophet of Pit1	PROP1	G
Propionyl-CoA carboxylase, alpha	PCCA	E
Propionyl-CoA carboxylase, beta	PCCB	E
Prosaposin	PSAP	N
Prostaglandin (PG) D synthase, hematopoietic	PGDS	E
Prostaglandin isomerase		G
Prostaglandin-endoperoxidase synthase 2	PTGS2	G
Prostate cancer anti-metastasis gene KAI1	KAI1	G
Protease nexin 2	PN2	E

Serotonin receptor, 5HT2C	HTR2C	N
Serotonin receptor, 5HT3	HTR3	N
Serotonin receptor, 5HT4	HTR4	N
Serotonin receptor, 5HT5	HTR5	N
Serotonin receptor, 5HT6	HTR6	N
Serotonin receptor, 5HT7	HTR7	N
Serum amyloid A	SAA	T
Serum amyloid P	SAP	T
Sex determining region Y, SRY	SRY	G
Short stature homeobox	SHOX	G
Sialoprotein, bone	BSP	G
Signal transducer and activator of transcription 1	STAT1	G
Signal transducer and activator of transcription 2	STAT2	G
Signal transducer and activator of transcription 3	STAT3	G
Signal transducer and activator of transcription 4	STAT4	G
Signal transducer and activator of transcription 5	STAT5	G
Signaling lymphocyte activation molecule	SLAM	I
Sine oculis homeobox, drosophila, homolog 1	SIX1	G
Sine oculis homeobox, drosophila, homolog 2	SIX2	G
Sine oculis homeobox, drosophila, homolog 5	SIX5	G
Sjogren (Sjogren) syndrome antigen A1	SSA1	I
Slug protein		G
Small nuclear ribonucleoprotein polypeptide N	SNRPN	S
Smoothelin	SMTN	G
Smoothed (Drosophila) homolog	SMOH	G
Sodium channel, non-voltage gated 1, alpha	SCNN1A	N
Sodium channel, non-voltage gated 1, beta	SCNN1B	N
Sodium channel, non-voltage gated 1, gamma	SCNN1G	N
Sodium channel, voltage gated, type IV, alpha polypeptide	SCN4A	N
Sodium channel, voltage gated, type V, alpha polypeptide	SCN5A	N
Sodium channel, voltage-gated, type 1, beta polypeptide	SCN1B	N
Solute carrier family 1 (amino acid transporter), member 6	SLC1A6	T
Solute carrier family 1 (glial high affinity glutamate transporter), member 3	SLC1A3	T
Solute carrier family 1 (glutamate transporter), member 1	SLC1A1	T
Solute carrier family 1 (glutamate transporter), member 2	SLC1A2	T
Solute carrier family 1 (neutral amino acid	SLC1A4	T

transporter), member 4		
Solute carrier family 10 (sodium/bile acid cotransporter family), member 1	SLC10A1	T
Solute carrier family 10 (sodium/bile acid cotransporter family), member 2	SLC10A2	T
Solute carrier family 12, member 1	SLC12A1	T
Solute carrier family 12, member 2	SLC12A2	T
Solute carrier family 12, member 3	SLC12A3	T
Solute carrier family 14, member 2	SLC14A2	T
Solute carrier family 15 (H <sup>+</sup> /peptide transporter, intestinal), member 1	SLC15A1	T
Solute carrier family 15 (H <sup>+</sup> /peptide transporter, kidney), member 2	SLC15A2	T
Solute carrier family 16 (monocarboxylate transporter), member 1	SLC16A1	T
Solute carrier family 16 (monocarboxylate transporter), member 7	SLC16A7	T
Solute carrier family 17, member 1	SLC17A1	T
Solute carrier family 17, member 2	SLC17A2	T
Solute carrier family 18, member 3	SLC18A3	T
Solute carrier family 19 (folate transporter), member 1	SLC19A1	T
Solute carrier family 2 (facilitated glucose transporter), member 1	SLC2A1	T
Solute carrier family 2 (facilitated glucose transporter), member 2	SLC2A2	T
Solute carrier family 2 (facilitated glucose transporter), member 3	SLC2A3	T
Solute carrier family 2 (facilitated glucose transporter), member 4	SLC2A4	T
Solute carrier family 2 (facilitated glucose transporter), member 5	SLC2A5	T
Solute carrier family 20, member 1	SLC20A1	T
Solute carrier family 20, member 2	SLC20A2	T
Solute carrier family 20, member 3	SLC20A3	T
Solute carrier family 21, member 2	SLC21A2	T
Solute carrier family 21, member 3	SLC21A3	T
Solute carrier family 22, member 1	SLC22A1	T
Solute carrier family 22, member 2	SLC22A2	T
Solute carrier family 22, member 5	SLC22A5	T
Solute carrier family 25, member 12	SLC25A12	T
Solute carrier family 3 (facilitated glucose transporter), member 1	SLC3A1	T
Solute carrier family 4 (anion exchanger), member 1	SLC4A1	T
Solute carrier family 4 (anion exchanger), member 2	SLC4A2	T
Solute carrier family 4 (anion exchanger),	SLC4A3	T

member 3		
Solute carrier family 5 (sodium/glucose transporter), member 1	SLC5A1	T
Solute carrier family 5 (sodium/glucose transporter), member 2	SLC5A2	T
Solute carrier family 5 (sodium/glucose transporter), member 5	SLC5A5	T
Solute carrier family 5, member 3	SLC5A3	T
Solute carrier family 6 (GAMMA-AMINOBUTYRIC ACID transporter), member 1	SLC6A1	T
Solute carrier family 6 (neurotransmitter transporter, dopamine), member 3	SLC6A3	T
Solute carrier family 6 (neurotransmitter transporter, noradrenaline), member 2	SLC6A2	T
Solute carrier family 6 (neurotransmitter transporter, serotonin), member 4	SLC6A4	T
Solute carrier family 6, member 10	SLC6A10	T
Solute carrier family 6, member 6	SLC6A6	T
Solute carrier family 6, member 8	SLC6A8	T
Solute carrier family 7(amino acid transporter), member 1	SLC7A1	T
Solute carrier family 7(amino acid transporter), member 2	SLC7A2	T
Solute carrier family 7(amino acid transporter), member 7	SLC7A7	T
Solute carrier family 8 (sodium/calcium exchanger), member 1	SLC8A1	T
Somatostatin receptor, SSTR2	SSTR2	G
Somatotrophin		G
Sonic hedgehog, SHH	SHH	G
Sorbitol dehydrogenase	SORD	E
Sorcin	SRI	T
SOS1 guanine nucleotide exchange factor	SOS1	G
Spastic paraplegia 7	SPG7	G
Spectrin alpha	SPTA1	S
Spectrin beta	SPTB	S
Sperm adhesion molecule	SPAM1	G
Sperm protamine P1	PRM1	G
Sperm protamine P2	PRM2	G
Sphingomyelinase	SMPD1	E
Spinocerebellar ataxia 8 gene	SCA8	N
Split hand/foot malformation gene	DSS1	G
SRY-box 10	SOX10	G
SRY-box 11	SOX11	G
SRY-box 3	SOX3	G
SRY-box 4	SOX4	G
SRY-box 9	SOX9	G
Stem cell factor	SCF	G

Steroid 5 alpha reductase 1	SRD5A1	E
Steroid 5 alpha reductase 2	SRD5A2	E
Steroid hormone receptor responsive DNA elements		G
Steroid sulphatase	STS	E
Steroidogenic acute regulatory protein	STAR	T
Stromal derived factor 1	SDF1	G
Succinate dehydrogenase 1	SDH1	E
Succinate dehydrogenase 2	SDH2	E
Succinate thiokinase		E
Succinic semi-aldehyde dehydrogenase	ssadh	E
Sulfamidase	SGSH	G
Sulfite oxidase	SUOX	E
Sulfonylurea receptor	SUR	G
Suppression of tumorigenicity 3 gene	ST3	G
Suppression of tumorigenicity 8 gene	ST8	G
Surfactant pulmonary-associated protein A1	SFTPA1	T
Surfactant pulmonary-associated protein A2	SFTPA2	T
Surfactant pulmonary-associated protein B	SFTPB	T
Surfactant pulmonary-associated protein C	SFTPC	T
Surfactant pulmonary-associated protein D	SFTPD	T
Surfeit 1	SURF1	G
Survival of motor neuron 1, telomeric	SMN1	T
SYK-related tyrosine kinase	SRK	I
Syndecan 1	SYND1	G
Syndecan 2	SYND2	G
Syndecan 3	SYND3	G
Syndecan 4	SYND4	G
Synovial sarcoma gene 1	SSX1	G
Synovial sarcoma gene 2	SSX2	G
Talin	TLN	G
TATA binding protein	TBP	G
TATA binding protein associated factor 2A	TAF2A	G
TATA binding protein associated factor 2C2	TAF2C2	G
TATA binding protein associated factor 2D	TAF2E	G
TATA binding protein associated factor 2F	TAF2F	G
TATA binding protein associated factor 2H	TAF2H	G
TATA binding protein associated factor 2I	TAF2I	G
TATA binding protein associated factor 2J	TAF2J	G
TATA binding protein associated factor 2K	TAF2K	G
Tau protein	MAPT	S
T-BOX 1	TBX1	G
T-BOX 2	TBX2	G
T-BOX 3	TBX3	G
T-BOX 4	TBX4	G
T-BOX 5	TBX5	G
T-BOX 6	TBX6	G
T-cell acute lymphocytic leukemia 1	TAL1	I

T-cell acute lymphocytic leukemia 2	TAL2	I
T-cell receptor, alpha	TCRA	I
T-cell receptor, delta	TCRD	I
Telomerase protein component		E
Tenascin (cytotactin)		S
Tenascin XA	TNXA	S
Terminal deoxynucleotidyltransferase, TDT		E
Testis-specific protein Y	TSPY	G
Thiolase, peroxisomal		E
Thiopurine S-methyltransferase	TPMT	E
Thrombopoietin	THPO	G
Thrombospondin	THBS1	G
Thromboxane A synthase 1	TBXAS1	I
Thromboxane A2	TXA2	I
Thromboxane A2 receptor	TBXA2R	I
Thy-1 T-cell antigen	THY1	I
Thymidylate synthase	TYMS	E
Thymopoietin	TMPO	G
Thyroglobulin	TG	G
Thyroid hormone receptor, alpha	THRA	G
Thyroid hormone receptor, beta	THRB	G
Thyroid peroxidase	TPO	G
Thyroid receptor auxiliary protein	TRAP	G
Thyroid-stimulating hormone receptor	TSHR	G
Thyroid-stimulating hormone, alpha	TSHA	G
Thyroid-stimulating hormone, beta	TSHB	G
Thyrotroph embryonic factor	TEF	G
Thyrotropin releasing hormone	TRH	G
Thyrotropin releasing hormone receptor	TRHR	G
Thyroxin-binding globulin	TBG	T
TIE receptor tyrosine kinase	TIE-1	G
Tip-associated protein	TAP	I
Tissue inhibitor of metalloproteinase 1, TIMP1	TIMP1	E
Tissue inhibitor of metalloproteinase 2, TIMP2	TIMP2	E
Tissue inhibitor of metalloproteinase 3, TIMP3	TIMP3	E
Tissue inhibitor of metalloproteinase 4, TIMP4	TIMP4	E
Tissue non-specific alkaline phosphatase		E
TNSAP		
Titin	TTN	S
Tocopherol (alpha) transfer protein	TPPA	T
Toll-like receptor 4	TLR4	I
Topoisomerase I		E
Topoisomerase II		E
Torticollis, keloids, cryptorchidism and renal dysplasia gene	TKCR	G
Transacylase		E
Transcobalamin 1, TCN1		T
Transcobalamin 2, TCN2	TCN2	T

Transcription factor 1, hepatic	TCF1	G
Transcription factor 2, hepatic	TCF2	G
Transcription factor 3	TCF3	G
Transcription factor binding to IGHM enhancer 3	TFE3	G
Transcription factor, TUPLE1	TUPLE1	N
Transcription termination factor, RNA polymerase 1	TTF1	G
Transcription termination factor, RNA polymerase 2	TTF2	G
Transcription termination factor, RNA polymerase 3	TTF3	G
Transferrin	TF	G
Transferrin receptor	TFRC	G
Transforming growth factor, alpha	TGFA	G
Transforming growth factor, beta 2	TGFB2	G
Transforming growth factor, beta induced	TGFB1	G
Transforming growth factor, beta receptor 2	TGFBR2	G
Transglutaminase 1	TGM1	G
Transglutaminase 2	TGM2	G
Transglutaminase 4	TGM4	G
Transketolase	TKT	E
Transketolase-like 1	TKTL1	E
Translocation in renal carcinoma on chromosome 8 gene	TRC8	G
Transthyretin	TTR	T
Treacle gene	TCOF1	G
Triosephosphate isomerase	TPI1	E
Tropomyosin 1 alpha	TPM1	S
Tropomyosin 3 (non-muscle)	TPM3	S
Troponin C		S
Troponin I	TNNI3	S
Troponin T2, cardiac	TNNT2	S
Trypsin inhibitor		E
Trypsinogen 1	TRY1	E
Trypsinogen 2	TRY2	E
Tryptophan hydroxylase	TPH	E
Tubby-like protein 1	TULP1	G
Tuberous sclerosis 1	TSC1	G
Tuberous sclerosis 2	TSC2	G
Tubulin		S
Tumor susceptibility gene 101	TSG101	G
Tumour necrosis factor (TNF) receptor associated factor 1	TRAF1	I
Tumour necrosis factor (TNF) receptor associated factor 2	TRAF2	I
Tumour necrosis factor (TNF) receptor associated factor 3	TRAF3	I



Tumour necrosis factor (TNF) receptor associated factor 4	TRAF4	I
Tumour necrosis factor (TNF) receptor associated factor 5	TRAF5	I
Tumour necrosis factor (TNF) receptor associated factor 6	TRAF6	I
Tumour necrosis factor alpha	TNFA	I
Tumour necrosis factor alpha receptor	TNFAR	I
Tumour necrosis factor beta	TNFB	I
Tumour necrosis factor beta receptor	TNFBR	I
Tumour protein p53	TP53, P53	G
Tumour protein p63	TP63	G
Tumour protein p73	TP73	G
Tumour protein, translationally-controlled 1	TPT1	G
Tumour suppressor gene DRA	DRA	I
Twist (Drosophila) homolog	TWIST	G
Tyrosinase	TYR	E
Tyrosinase-related protein 1	TYRP1	E
Tyrosine aminotransferase	TAT	E
Tyrosine hydroxylase	TH	E
Ubiquitin		G
Ubiquitin activating enzyme, E1		E
Ubiquitin B	UBB	G
Ubiquitin C	UBC	G
Ubiquitin carboxyl-terminal esterase L1	UCHL1	G
Ubiquitin fusion degeneration 1-like	UFD1L	G
Ubiquitin protein ligase E3A	UBE3A	E
UDP-glucose pyrophosphorylase		E
UDP-glucuronosyltransferase 1	ugt1d, UGT1	E
UDP-glucuronosyltransferase 2	UGT2	E
Uncoupling protein 1		T
Uncoupling protein 3	UCP3	T
Undulin 1	COL14A1	S
Uridine monophosphate kinase	UMPK	I
Uridine monophosphate synthetase	UMPS	I
Uridinediphosphate(UDP)-galactose-4-epimerase	GALE	E
Uroporphyrinogen decarboxylase	UROD	E
Uroporphyrinogen III synthase	UROS	E
Usher syndrome 2A	USH2A	S
Vascular endothelial growth factor	VEGF	G
Vasoinhibitory peptide		G
Vitamin B12-binding (R) protein		G
Vitamin D receptor	VDR	G
Vitelliform macular dystrophy, atypical gene	VMD1	T
v-myc avian myelocytomatosis viral oncogene homolog	MYC	G
Von Hippel-Lindau gene	VHL	G

Werner syndrome helicase	WRN	G
Wilms tumour gene 1	WT1	G
Wilms tumour gene 2	WT2	G
Wilms tumour gene 4	WT4	G
Winged helix nude	WHN	G
Wingless family, wnt2	WNT2	G
Wingless family, wnt4	WNT4	G
Wingless family, wnt5	WNT5	G
Wingless family, wnt7	WNT7	G
Wingless family, wnt8	WNT8	G
Wiskott-Aldrich syndrome protein	WASP, THC	I
Wnt inhibitory factor, WIF-1	WIF1	G
Wolf-Hirschhorn syndrome candidate 1 gene	WHSC1	G
Wolfram syndrome 1 gene	WFS1	S
X (inactive)-specific transcript	XIST	G
Xanthine dehydrogenase	XDH	E
Xeroderma pigmentosum, complementation group A	XPA	E
Xeroderma pigmentosum, complementation group B	XPB	E
Xeroderma pigmentosum, complementation group C	XPC	E
Xeroderma pigmentosum, complementation group D		E
Xeroderma pigmentosum, complementation group E		E
Xeroderma pigmentosum, complementation group F	XPF	E
Xeroderma pigmentosum, complementation group G	ERCC5	E
X-ray repair gene	XRCC9	G
Xylitol dehydrogenase		E
YY1 transcription factor	YY1	G
Zinc finger protein 198	ZIC198	S
Zinc finger protein 2	ZIC2	S
Zinc finger protein 3	ZIC3	S
Zinc finger protein HRX	ALL1	I
Zona pellucida glycoprotein 1	ZP1	G
Zona pellucida glycoprotein 2	ZP2	G
Zona pellucida glycoprotein 3	ZP3	G
Zona pellucida receptor tyrosine kinase	ZRK	G
Zonadhesin	ZAN	G

In a thirteenth aspect.

### SKIN, MUSCLE, CONNECTIVE TISSUE AND BONE.

The present invention relates to a method of assessing the risk of developing clinical or social consequences following dysfunction, damage or disease of the skin, muscle, connective tissue or bone and indicating appropriate therapeutic interventions.

The skin, muscle, connective tissue and bone constitute the scaffolding of the body, their structural properties enable the body to maintain its shape, allow articulation and movement of limbs and act as anchor points for the location and attachment of other organs.

The skin forms the initial defensive barrier between the body and the external environment. It consists of the epidermis (containing the sweat and apocrine glands) and dermis lying on a layer of fat. Within these layers lie a series of specialised cells such as dendritic cells, Langerhans cells and intermediate cells. The skin is also richly supplied with nerves and blood vessels. Together these tissues enable the skin to present a supple but sensitive barrier between the external environment and the body. The skin is exposed to pathogens and injury at all times and as such it has impressive defensive, repair and regenerative capacities. In order to facilitate these functions the skin cells 'turn over' in about 30 days, thus ensuring a continuous process of renewal and the maintenance of an efficient barrier. The skin is also responsible for the detection of environmental stimuli such as heat, cold, pressure and antigen detection. The skin can also manifest the body's responses to such stimuli by enabling heat loss through vasodilation or resistance to infection by focal inflammatory responses. In humans the skin plays an important part in sexual attraction and this has very significant implications for the extent and nature of disabilities experienced or perceived following dysfunction, damage or disease.

The most common forms of skin diseases are; acne, warts, tumours, dermatitis, psoriasis, leg ulcers and infections (bacterial, viral and fungal). There are also a host of rarer genetic or metabolic disorders including: epidermolysis bullosa, neurofibromatosis, ichthyosis vulgaris, Down's syndrome, atopic eczema, acne vulgaris, alopecia areata, Werner's syndrome etc. (Weatherall, Ledingham and Warrell 1996).

One particular aspect of the presence of diseases of the skin is the social stigma and isolation which arise as a consequence of them. Although seldom life threatening, the disability and decline in quality of life experienced by the patient is often out of all proportion to the clinical severity of the condition.

Muscle tissues supply the physical power to move the limbs of the body and to enable more discrete processes such as peristalsis, breathing and ejaculation. Muscle is made up of muscle fibres (multinucleate cells containing myofibrils, sarcoplasm, mitochondria, ribosomes and the sarcotubular system). Each fibre is enclosed in a sarcolemmal sheath and has a motor endplate where nerve fibres terminate. The muscle fibres work in groups to ensure a co-ordinated application of force.

Pain, muscular weakness and fatiguability are the most important symptoms of dysfunction, damage and disease of the muscle. In order to arrive at a specific diagnosis of a disease or syndrome the distribution, nature and dynamics of the muscular symptoms must be carefully assessed (e.g. genetic causes of muscular disease tend to have an insidious progression of muscle weakness, whereas inflammatory causes occur more rapidly).

Diseases of muscle include genetic causes (the dystrophies, myotonias), hypotonias of uncertain cause, inflammatory myopathies, disorders of neuro-muscular transmission (e.g. myasthenia gravis, Lambert-Eaton myasthenic syndrome) and mitochondrial, metabolic or endocrine related myopathies.

In addition muscular symptoms can often occur as a presenting symptom in neurological diseases such as multiple sclerosis, motor neurone disease and Parkinson's disease. Adverse reactions to drug therapies can also result in the symptoms of muscle disease (e.g. antibiotics, procainamide, D-penicillamine).

Connective tissues form the thin membranes of tissue which encompass and link the various organs and tissues of the body together. They form support structure for the organs and the vascular, nervous and lymphatic vessels and fibres which run between them. Connective tissues consist largely of collagen, laminins and fibronectins.

Diseases of connective tissue form a diverse group of syndromes many of which are of unknown etiology e.g. systemic lupus erythematosus, scleroderma, vasculitides and Sjogren's syndrome). These diseases have a common thread of pathology in that they all involve aberrant activation or regulation of the immune system. Several can be precipitated or exacerbated by certain drugs or exposure to environmental toxins. The symptoms diffuse and often involve several systems (e.g. arthralgias, myalgias, skin rashes, hair loss, breathlessness etc.) Diagnosis can be difficult particularly in the more diffuse presentations, the presence of antinuclear antibodies is often helpful in confirming a diagnosis. These conditions are thought to be triggered, in the main, by responses to external environmental factors.

Rheumatology concerns the pathological process which affect joints and periarticular tissues. It involves diseases of the musculo-skeletal system such as genetic abnormalities of specific component tissues, abnormalities of the immune system, acute and chronic inflammatory responses and the turnover and regulation of connective tissues (e.g. bone, cartilage). The World Health Organisation classifies rheumatic disorders into four main categories:

Back pain

Periarticular disorders

Osteoarthritis and related disorders

Inflammatory arthropathies (e.g. rheumatoid arthritis, ankylosing spondylitis)

Rheumatic disorders are very common and the experience of pain in muscles or joints is one of the commonest reasons for consulting a doctor. Since joint or muscle pain is a feature of physical exertion and exercise it is sometimes difficult to draw the

boundary between 'normal' and 'pathological' joint and muscle pain. Given the frequency of this type of complaint the economic consequences of such disorders are immense and they are calculated to be responsible for 30% of the burden of disability in the population (rising to over 60% in the ageing population).

Rheumatic disorders present with a variety of symptoms both articular (e.g. pain, stiffness, swelling and loss of function in joints) and extra-articular (e.g. scleritis, systemic sclerosis, xerostomia, psoriasis, ulcerative colitis, urethritis, peripheral neuropathies). A careful clinical examination is required to determine the range of symptoms present and thus the exact diagnosis (e.g. whether arthritis is due to a bacterial infection).

Bone is one of two tissues in the body (teeth are the other) which is mineralised in order to carry out its normal functions, to act as a rigid framework for muscle and organ attachment and to act as a mineral store. Bone tissue consists of cells and an extracellular mineralised matrix. Three types of cells are present, osteoblasts, osteoclasts and osteocytes. All three types are involved in the complex processes of bone formation and resorption. In addition these cells have close contacts with bone marrow and thus the immune system. Bone metabolism is affected by factors such as mechanical stress, hormones and inflammatory mediators such as cytokines. The process of bone re-modelling continues throughout life and as such will be affected by concurrent illness or hormonal changes during ageing (e.g. osteoporosis is a common problem in post-menopausal women).

In addition to the damage caused by fractures, infections and tumours bone has a number of other pathologies including Weatherall, Leadingham and Warrell 1996): Aberrations of bone formation or resorption (osteoporosis, osteomalacia, Paget's disease)

Defects in the main molecular components of bone formation (Marfan's syndrome, osteogenesis imperfecta)

Disorders of the enzymes of bone metabolism (homocystinuria, hypophosphatasia)

Skeletal chondroplasias

Abberant biology of bone cells (osteopetrosis, ectopic ossification, fibrous dysplasia)

Toxic effects due to excess minerals, vitamins or metallic poisons.

The main consequences of these disorders involve, unsightly lesions, sores, ulcerations, infections, musculoskeletal pain, stiffness, reduced mobility, dysfunction of specific organs, physical disability and enhanced susceptibility to fractures. These physical features will impact on an individuals quality of life and as such the disorder is often complicated by complex interactions with an individuals social circumstances and psychology (Weatherall, Leadingham and Warrell 1996).

The physiology and structure of skin, muscle, connective tissue and bone is extremely complex and involves the initiation of repair and regenerative mechanisms and the body's response to changes in the environment (e.g. changes in physical activity leading to increased muscle mass and bone density or muscular changes in pregnancy). The co-ordination of a changing pattern of behaviour or environmental stressor with musculoskeletal changes or the initiation of wound closure and healing

following trauma involve synergistic or inhibitory interaction between multiple regulatory pathways and molecular cascades. Variation in the functionality of the proteins involved in these processes will, inevitably, cause or have an impact on the functioning of these systems or an individuals attempts to minimise damage and restore function following dysfunction, damage or disease in these systems. A number of constitutional factors are known to impact on the individuals ability to deal with and recover from dysfunction, damage or disease of the skin, muscle, connective tissue or bone including genetic history, age, sex, nutritional status, pre-existing disease or injury, drug treatments and socio-economic circumstances.

Genetic variation within individuals is also a key factor although the extent and nature of the genes involved and their precise impact on prognosis, complications, efficacy of therapeutic intervention and eventual recovery of function is largely unknown.

The individual variability in response to the occurrence of skin, muscle, connective tissue and bone pathology and the associated variation in symptomatology, response to therapy and adverse events resulting from therapeutic interventions lies at the heart of the difficulties experienced in the healthcare and social management of dysfunction, damage or disease of the skin, muscle, connective tissue or bone.

We have elaborated on the value and utility to be derived from the gathering together of the genes which form the core gene list for this particular Genostic system.

These genes are elaborated below:

#### KEY TO 'PROTEIN FUNCTION' COLUMN

E ENZYME  
T TRANSPORT & STORAGE  
S STRUCTURAL  
I IMMUNITY  
N NERVOUS TRANSMISSION  
G GROWTH & DIFFERENTIATION

SKIN, BONE, MUSCLE GENE LIST	HUGO symbol	Protein function
17beta hydroxysteroid oxidoreductase		E
5,10-methylenetetrahydrofolate reductase (NADPH)	MTHFR	E
6-phosphofructo-2-kinase	PFKFB1	E
Acetoacetyl 2-CoA-thiolase	ACAT2	E
Acetylcholine receptor, nicotinic, alpha A1	CHRNA1	N
Acetylcholine receptor, nicotinic, alpha A2	CHRNA2	N
Acetylcholine receptor, nicotinic, alpha A3	CHRNA3	N
Acetylcholine receptor, nicotinic, alpha A4	CHRNA4	N
Acetylcholine receptor, nicotinic, alpha A5	CHRNA5	N
Acetylcholine receptor, nicotinic, alpha A6	CHRNA6	N
Acetylcholine receptor, nicotinic, alpha A7	CHRNA7	N
Acetylcholine receptor, nicotinic, beta 1	CHRNA1	N
Acetylcholine receptor, nicotinic, beta 2	CHRNA2	N

Acetylcholine receptor, nicotinic, beta 3	CHRNA3	N
Acetylcholine receptor, nicotinic, beta 4	CHRNA4	N
Acetylcholine receptor, nicotinic, epsilon	CHRNAE	N
Acetylcholine receptor, nicotinic, gamma	CHRNAG	N
Acetylcholinesterase	ACHE	E
Achromatopsia 2	ACHM2	S
Acid phosphatase 2, lysosomal	ACP2	E
Actin, alpha, cardiac	ACTC	S
Actin, alpha, skeletal	ACTA1	S
Actin, alpha, smooth, aortic	ACTA2	S
Actin, beta	ACTB	S
Actin, gamma 2	ACTG2	S
Activin		G
Acyl CoA dehydrogenase, short chain	ACADS	E
Acyl-CoA thioesterase		E
Adaptin, beta 3A	ADTB3A	T
Adducin, alpha	ADD1	S
Adducin, beta	ADD2	S
Adenosine deaminase	ADA	E
Adenosine monophosphate deaminase	AMPD	E
Adenosine receptor A1	ADORA1	N
Adenosine receptor A2A	ADORA2A	N
Adenosine receptor A2B	ADORA2B	N
Adenosine receptor A3	ADORA3	N
Adenyl cyclase		N
Adenylate cyclase 1	ADCY1	E
Adenylate cyclase 2	ADCY2	E
Adenylate cyclase 3	ADCY3	E
Adenylate cyclase 4	ADCY4	E
Adenylate cyclase 5	ADCY5	E
Adenylate cyclase 6	ADCY6	E
Adenylate cyclase 7	ADCY7	E
Adenylate cyclase 8	ADCY8	E
Adenylate cyclase 9	ADCY9	E
Adenylate kinase	AK1	E
Adenylosuccinate lyase	ADSL	E
Adrenergic receptor, alpha1	ADRA1	N
Adrenergic receptor, alpha2	ADRA2	N
Adrenergic receptor, beta1	ADRB1	N
Adrenergic receptor, beta2	ADRB2	N
Adrenergic receptor, beta3	ADRB3	N
Adrenocorticotrophic hormone (ACTH) receptor	ACTHR	G
Adrenoleukodystrophy gene	ALD	E
Alanine aminotransferase		T
Alanine-glyoxylate aminotransferase	AGXT	E
Albumin, ALB	ALB	T
Alcohol dehydrogenase 1	ADH1	E

Alcohol dehydrogenase 2	ADH2	E
Alcohol dehydrogenase 3	ADH3	E
Alcohol dehydrogenase 4	ADH4	E
Alcohol dehydrogenase 5	ADH5	E
Alcohol dehydrogenase 6	ADH6	E
Alcohol dehydrogenase 7	ADH7	E
Aldehyde dehydrogenase 1	ALDH1	E
Aldehyde dehydrogenase 10	ALDH10	E
Aldehyde dehydrogenase 2	ALDH2	E
Aldehyde dehydrogenase 5	ALDH5	E
Aldehyde dehydrogenase 6	ALDH6	E
Aldehyde dehydrogenase 7	ALDH7	E
Aldolase A	ALDOA	E
Aldolase B	ALDOB	E
Aldolase C	ALDOC	E
Aldosterone receptor	MLR	G
Alkaline phosphatase, liver/bone/kidney	ALPL	T
Alkaptonuria gene	AKU	G
Alkylglycerone phosphate synthase	AGPS	E
alpha tectorin	TECTA	G
alpha thalassemia gene	ATRX	N
alpha1-antichymotrypsin	AACT	E
alpha1-antitrypsin	PI	E
alpha2-antiplasmin	PLI	E
alpha-actinin 2	ACTN2	G
alpha-actinin 3	ACTN3	G
alpha-Galactosidase A	GLA	E
Alpha-galactosidase B, GALB	NAGA	E
alpha-synuclein	SNCA	N
Amelogenin	AMELX	S
Aminopeptidase P	XPNPEP2	E
Amphiregulin	AREG	G
Amylo-1,6-glucosidase	AGL	E
Amyloid beta A4 precursor protein	APP	N
Amyloid beta A4 precursor-like protein	APLP	N
Androgen binding protein	ABP	T
Androgen receptor	AR	G
Angiopoietin 1	ANGPT1	G
Angiopoietin 2	ANGPT2	G
Angiotensin converting enzyme	ACE, DCP1	E
Angiotensinogen	AGT	E
Antidiuretic hormone receptor	ADHR	T
Anti-Mullerian hormone	AMH	G
Apolipoprotein A 4	APOA4	T
Apolipoprotein A I	APOA1	T
Apolipoprotein A II	APOA2	T
Apolipoprotein B	APOB	T
Apolipoprotein C1	APOC1	T



Apolipoprotein C2	APOC2	T
Apolipoprotein C3	APOC3	T
Apolipoprotein D	APOD	T
Apolipoprotein E	APOE	T
Apolipoprotein H	APOH	T
Arginine vasopressin	AVP	N
Arginine vasopressin receptor 1A	AVPR1A	N
Arginine vasopressin receptor 1B	AVPR1B	N
Arginine vasopressin receptor 2	AVPR2	N
Arrestin	SAG	S
Aryl hydrocarbon receptor nuclear translocator	ARNT	T
Arylsulfatase A	ARSA	E
Arylsulfatase B	ARSB	E
Arylsulfatase C	ARSC1	E
Arylsulfatase D	ARSD	E
Arylsulfatase E	ARSE	E
Arylsulfatase F	ARSF	E
Aspartate receptor		N
Aspartoacylase	ASPA	E
Aspartylglucosaminidase	AGA	E
Ataxia telangiectasia complementation group D	ATD, ATDC	G
Ataxia telangiectasia gene, AT	ATM	G
ATP cobalamin adenosyltransferase		E
ATP sulphurylase	atpsk2	E
ATP/ADP translocase		E
Attractin		I
Autoimmune regulator, AIRE	AIRE	I
BCL2-related protein A1	BCL2A1	G
Benzodiazepine receptor		N
Bestrophin	VMD2	T
beta 2 microglobulin	B2M	I
beta-endorphin receptor		N
beta-galactosidase	GLB1	E
beta-Glucuronidase	GUSB	E
beta-synuclein	SNCB	N
Bilirubin UDP-glucuronosyltransferase		E
Bloom syndrome protein	BLM	G
Blue cone pigment	BCP	S
Bone morphogenetic protein, BMP1	BMP1	G
Bone morphogenetic protein, BMP2	BMP2	G
Bone morphogenetic protein, BMP3	BMP3	G
Bone morphogenetic protein, BMP4	BMP4	G
Bone morphogenetic protein, BMP5	BMP5	G
Bone morphogenetic protein, BMP6	BMP6	G
Bone morphogenetic protein, BMP7	BMP7	G
Bone morphogenetic protein, BMP8	BMP8	G

Bradykinin receptor B1		I
Bradykinin receptor B2		I
Branched chain aminotransferase 1, cytosolic	BCAT1	E
Branched chain aminotransferase 2, mitochondrial	BCAT2	E
Breast cancer, ductal, 1	BRCD1	G
Breast cancer, ductal, 2	BRCD2	G
Butyrylcholinesterase	BCHE	E
Ca(2+) transporting ATPase, fast twitch	ATP2A1	T
Ca(2+) transporting ATPase, slow twitch	ATP2A2	T
Cadherin E	CDH1	G
Cadherin EP		G
Cadherin N	CDH2	G
Cadherin P	CDH3	G
Calbindin 1	CALB1	G
Calbindin D9K	CALB3	G
Calcitonin receptor /Calcitonin gene-related peptide receptor	CALCR	N
Calcitonin/Calcitonin gene-related peptide alpha	CALCA	N
Calcium channel, voltage-dependent, L type, alpha 1S subunit	CACNA1S	N
Calcium channel, voltage-dependent, P/Q type, alpha 1A subunit	CACNA1A	N
Calmodulin 1	CALM1	G
Calmodulin 2	CALM2	G
Calmodulin 3	CALM3	G
Calnexin	CANX	G
Calpain	CAPN, CAPN3	E
Cannabinoid receptor	CNR1	N
Carbonic anhydrase 3	CA3	E
Carbonic anhydrase 4	CA4	E
Carbonic anhydrase, alpha	CA1	E
Carbonic anhydrase, beta	CA2	E
Carnitine acetyltransferase	CRAT	E
Carnitine acylcarnitine translocase	CACT	E
Carnitine palmitoyltransferase I	CPT1A	E
Carnitine palmitoyltransferase II	CPT2	E
Carnitine transporter protein	CDSP, SCD	T
Cartilage oligomeric matrix protein	COMP, EDM1, PSACH	N
Cartilage-hair hypoplasia gene	CHH	N
Catenin, beta	CTNNB1	G
Cathepsin K	CTSK	E
Caveolin 3	CAV3	E
CD1	CD1	I
CD4	CD4	I
Ceroid lipofuscinosis neuronal 3	CLN3	N

Ceruloplasmin precursor	CP	E
Chemokine MCAF	MCAF	I
Chloride channel 1, skeletal muscle	CLCN1	S
Cholecystokinin	CCK	N
Cholecystokinin B receptor	CCKBR	N
Cholesterol ester hydroxylase		E
Choline acetyltransferase	CHAT	E
Choroideremia gene	CHM	S
Citrate synthase		E
Clathrin		T
Cleft palate gene	CPX	G
Cockayne syndrome gene, CKN1	CKN1	G
Coenzyme Q (CoQ)/ubiquinone		E
Collagen I alpha 1	COL1A1	S
Collagen I alpha 2	COL1A2	S
Collagen II alpha 1	COL2A1	S
Collagen III alpha 1	COL3A1	S
Collagen IV alpha 1	COL4A1	S
Collagen IV alpha 2	COL4A2	S
Collagen IV alpha 3	COL4A3	S
Collagen IV alpha 4	COL4A4	S
Collagen IV alpha 5	COL4A5	S
Collagen IV alpha 6	COL4A6	S
Collagen IX alpha 2	COL9A2, EDM2	S
Collagen IX alpha 3	COL9A3	S
Collagen receptor	COLR	S
Collagen V alpha 1	COL5A1	S
Collagen V alpha 2	COL5A2	S
Collagen VI alpha 1	COL6A1	S
Collagen VI alpha 2	COL6A2	S
Collagen VI alpha 3	COL6A3	S
Collagen VII alpha 1	COL7A1	S
Collagen X alpha 1	COL10A1	S
Collagen X alpha 1	COL11A1	S
Collagen XI alpha 2	COL11A2	S
Collagen XVII alpha 1	COL17A1	S
Collagenic-like tail subunit of asymmetric acetylcholinesterase	COLQ	E
Collapsin		G
Colony-stimulating factor 1	CSF1	G
Colony-stimulating factor 1 receptor	CSF1R	G
Colony-stimulating factor 2	CSF2	G
Colony-stimulating factor 2 alpha receptor	CSF2RA	G
Colony-stimulating factor 2 beta receptor	CSF2RB	G
Colony-stimulating factor 3	CSF3	G
Colony-stimulating factor 3 receptor	CSF3R	G
Complement component C1 inhibitor	C1NH	I
Complement component C1qa	C1QA	I

Complement component C1qb	C1QB	I
Complement component C1qg	C1QG	I
Complement component C1r	C1R	I
Complement component C1s	C1S	I
Complement component C2	C2	I
Complement component C3	C3	I
Complement component C4A	C4A	I
Complement component C4B	C4B	I
Complement component C5	C5	I
Complement component C6	C6	I
Complement component C7	C7	I
Complement component C8	C8B	I
Complement component C9	C9	I
Complement component receptor 1	CR1	I
Complement component receptor 2	CR2	I
Complement component receptor 3	CR3	I
Complex I		E
Complex II		E
Complex III		E
Complex III		E
Complex V	MTATP6	E
Cone-rod homeobox-containing gene	CRX	G
Coproporphyrinogen oxidase	CPO	E
Core-binding factor, alpha 1	CBFA1	G
Core-binding factor, alpha 2	CBFA2	G
Core-binding factor, beta	CBFB	G
Corticosteroid binding globulin	CBG	N
Cortico-steroid binding protein		T
Corticotrophin-releasing hormone	CRH	T
Corticotrophin-releasing hormone receptor	CRHR1	T
Cortisol receptor		I
C-reactive protein CRP		I
Creatine kinase – B and m	CKBE	E
Creb binding protein	CREBBP	G
Crystallin, alpha A	CRYAA	S
Crystallin, alpha B	CRYAB	S
Crystallin, beta B2	CRYBB2	S
Crystallin, gamma A	CRYGA	S
c-src tyrosine kinase	CSK	G
Cu <sup>2+</sup> transporting ATPase alpha polypeptide	ATP7A	E
Cu <sup>2+</sup> transporting ATPase beta polypeptide	ATP7B	E
Cyclic AMP response element binding protein	CREB	G
Cyclic AMP-dependent protein kinase	PKA	E
Cyclic nucleotide phosphodiesterase 1B	PDE1B	E
Cyclic nucleotide phosphodiesterase 1B1	PDE1B1	E
Cyclic nucleotide phosphodiesterase 2A3	PDE2A3	E
Cyclic nucleotide phosphodiesterase 3A	PDE3A	E
Cyclic nucleotide phosphodiesterase 3B	PDE3B	E

Cyclic nucleotide phosphodiesterase 4A	PDE4A	E
Cyclic nucleotide phosphodiesterase 4C	PDE4C	E
Cyclic nucleotide phosphodiesterase 5A	PDE5A	E
Cyclic nucleotide phosphodiesterase 6A	PDE6A	E
Cyclic nucleotide phosphodiesterase 6B	PDE6B	E
Cyclic nucleotide phosphodiesterase 7	PDE7	E
Cyclic nucleotide phosphodiesterase 8	PDE8	E
Cyclic nucleotide phosphodiesterase 9A	PDE9A	E
Cyclin-dependent kinase 2	CDK2	G
Cyclin-dependent kinase inhibitor 1C (P57, KIP2)	CDKN1C	G
Cyclin-dependent kinase inhibitor 2A (p16)	CDKN2A	G
Cyclooxygenase 1	COX1	E
Cyclooxygenase 2	COX2	E
CYP11A1	CYP11A1	E
CYP11B1	CYP11B1	E
CYP11B2	CYP11B2	E
CYP17	CYP17	E
CYP19	CYP19	E
CYP1A1	CYP1A1	E
CYP1A2	CYP1A2	E
CYP1B1	CYP1B1	E
CYP21	CYP21	E
CYP24	CYP24	E
CYP27	CYP27	E
CYP27B1	PDDR	E
CYP2A1	CYP2A1	E
CYP2A13	CYP2A13	E
CYP2A3	CYP2A3	E
CYP2A6V2	CYP2A6V2	E
CYP2A7	CYP2A7	E
CYP2B6	CYP2B6	E
CYP2C18	CYP2C18	E
CYP2C19	CYP2C19	E
CYP2C8	CYP2C8	E
CYP2C9	CYP2C9	E
CYP2D6	CYP2D6	E
CYP2E1	CYP2E1	E
CYP2F1	CYP2F1	E
CYP2J2	CYP2J2	E
CYP3A3	CYP3A3	E
CYP3A4	CYP3A4	E
CYP3A5	CYP3A5	E
CYP3A7	CYP3A7	E
CYP4A11	CYP4A11	E
CYP4B1	CYP4B1	E
CYP4F2	CYP4F2	E
CYP4F3	CYP4F3	E

CYP51	CYP51	E
CYP5A1	CYP5A1	E
CYP7A	CYP7A	E
CYP8	CYP8	E
Cystathionase	CTH	E
Cystathione beta synthase	CBS	E
Cystic fibrosis transmembrane conductance regulator, CFTR	CFTR	N
Cystinosin	CTNS	T
Cytidine deaminase	CDA	E
Cytidine-5-prime-triphosphate synthetase	CTPS	E
Cytochrome a		E
Cytochrome b-245 alpha	CYBA	E
Cytochrome b-245 beta	CYBB	E
Cytochrome b-5	CYB5	E
Cytochrome c		E
Cytochrome c oxidase, MTCO		E
Cytokine-suppressive antiinflammatory drug- binding protein 1	CSBP1	I
Cytokine-suppressive antiinflammatory drug- binding protein 2	CSBP2	I
DAX1 nuclear receptor	DAX1	I
Deafness dystonia peptide	DDP	N
Delta 4-5 alpha-reductase		E
Delta aminolevulinate dehydratase	ALAD	E
Delta(4)-3-oxosteroid 5-beta-reductase		E
Delta-7-dehydrocholesterol reductase	DHCR7	E
Dentin sialophosphoprotein	DSPP	G
Desmin	DES	S
DHEA sulfotransferase	STD	E
Diastrophic dysplasia sulfate transporter	DTD	T
Dihydrolipoamide dehydrogenase	DLD	N
Dihydroxyacetonephosphate acyltransferase	DHAPAT	E
DNA damage binding protein, DDB1	DDB1	S
DNA damage binding protein, DDB2	DDB2	S
DNA methyltransferase	DNMT	E
DNA-damage-inducible transcript 3	DDIT3	S
Dopamine receptors D1	DRD1	N
Dopamine receptors D2	DRD2	N
Dopamine receptors D3	DRD3	N
Dopamine receptors D4	DRD4	N
Dopamine receptors D5	DRD5	N
Dynamin	DNM1	G
Dynorphin receptor		N
Dyskerin	DKC1	S
Dystonia 1	DYT1	S
Dystonia 3	DYT3	S
Dystonia 6	DYT6	S

Dystonia 7	DYT7	S
Dystrophia myotonica	DM, DMPK	E
Dystrophia myotonica, atypical	DM2	E
Dystrophin	DMD	S
Dystrophin-associated glycoprotein 35kD, SCGD	SGCD	S
Dystrophin-associated glycoprotein 35kD, SGSG	SGCG	S
Dystrophin-associated glycoprotein 43kD	SGCB	S
Dystrophin-associated glycoprotein 50kD	SGCA	S
Ectodermal Dysplasia 1 gene	ED1	S
Elastase 1	ELAS1	E
Elastase 2	ELAS2	E
Elastin	ELN	S
Electron-transferring-flavoprotein alpha	ETFA	T
Electron-transferring-flavoprotein beta	ETFB	T
Electron-transferring flavoprotein dehydrogenase	ETFDH	E
Emerin	EMD	T
Endocardial fibroelastosis 2 gene	EFE2	S
Endometrial bleeding-associated factor	EBAF	G
Endothelin 1	EDN1	N
Endothelin 2	EDN2	N
Endothelin 3	EDN3	N
Endothelin converting enzyme	ECE1	N
Endothelin receptor type A	EDNRA	N
Endothelin receptor type B	EDNRB	N
Engrailed-1	EN1	G
Engrailed-2	EN2	G
Enolase	ENO1	E
Enoyl CoA hydratase		E
Enoyl CoA isomerase		E
Enoyl CoA reductase		E
Enterokinase	PRSS7, ENTK	E
Ephrin receptor tyrosine kinase A	EPHA	G
Ephrin receptor tyrosine kinase B	EPHB	G
Epidermal growth factor	EGF	G
Epidermal growth factor receptor	EGFR	G
Erythrocyte membrane protein band 4.1	EPB41	S
Erythropoietin	EPO	I
Erythropoietin receptor	EPOR	I
Estrogen receptor	ESR	G
Exostosin 1	EXT1	S
Exostosin 2	EXT2	S
Exostosin 3	EXT3	S
Eye colour gene 3 (brown)	EYCL3	S
Eyes absent 1	EYA1	G
Faciogenital dysplasia	FGD1, FGDY	T

Factor 1 (No. one)	F1	I
Factor B, properdin		I
Factor D		I
Factor H	HF1	I
Factor X	F10	I
Fanconi anemia, complementation group A	FANCA	T
Fanconi anemia, complementation group C	FANCC	T
Fanconi anemia, complementation group D	FANCD	T
Fc fragment of IgG, high affinity IA, receptor for	FCGR1A	G
Fc fragment of IgG, low affinity IIa, receptor for (CD32)	FCGR2A	G
Ferritin, H subunit		T
Ferritin, L subunit	FTL	T
Fibrillin 1	FBN1	G
Fibrillin 2	FBN2	G
Fibrinogen alpha	FGA	S
Fibrinogen beta	FGB	S
Fibrinogen gamma	FGG	S
Fibroblast growth factor	FGF1	G
Fibroblast growth factor receptor 1	FGFR1	G
Fibroblast growth factor receptor 2	FGFR2	G
Fibroblast growth factor receptor 3	FGFR3	G
Fibronectin precursor	FN1	G
Flightless-II, Drosophila homolog of	FLII	G
Folic acid receptor	FOLR	G
Follicle stimulating hormone receptor	FSHR, ODG1	G
Follicle stimulating hormone, FSH	FSHB	G
Forkhead transcription factor 10	FKHL10	G
Forkhead transcription factor 14	FKHL14	G
Forkhead transcription factor 7	FKHL7	G
Fragile site, folic acid type, rare, fra(X) A	FRAXA	N
Frataxin	FRDA	G
Fringe secreted protein, lunatic	LFNG	G
Fringe secreted protein, manic	MFNG	G
Fringe secreted protein, radical	RFNG	G
Fructose-1,6-diphosphatase	FBP1	E
Fucosidase alpha-L-1	FUCA1	E
Fucosidase alpha-L-2		E
Fukuyama type congenital muscular dystrophy	FCMD	G
Fumarase	FH	E
GABA receptor, alpha 1	GABRA1	N
GABA receptor, alpha 2	GABRA2	N
GABA receptor, alpha 3	GABRA3	N
GABA receptor, alpha 4	GABRA4	N
GABA receptor, alpha 5	GABRA5	N
GABA receptor, alpha 6	GABRA6	N



GABA receptor, beta 1	GABRB1	N
GABA receptor, beta 2	GABRB2	N
GABA receptor, beta 3	GABRB3	N
GABA receptor, gamma 1	GABRG1	N
GABA receptor, gamma 2	GABRG2	N
GABA receptor, gamma 3	GABRG3	N
Galactocerebrosidase	GALC	E
Galactokinase	GALK1	E
Galactose 1-phosphate uridyl-transferase	GALT	E
Gamma-glutamyl carboxylase	GGCX	T
Gap junction protein alpha 3	GJA3	T
Gap junction protein alpha 8	GJA8	T
Gap junction protein beta 3	GJB3	T
Gastrointestinal tumor-associated antigen 1	GA733	I
Gastrulation brain homeobox 2	GBX2	G
Glucosidase, acid alpha	GAA	E
Glucosidase, acid beta	GBA	E
Glutamate receptor 1	GLUR1	N
Glutamate receptor 2	GLUR2	N
Glutamate receptor 3	GLUR3	N
Glutamate receptor 4	GLUR4	N
Glutamate receptor 5	GLUR5	N
Glutamate receptor 6	GLUR6	N
Glutamate receptor 7	GLUR7	N
Glutamate receptor, ionotropic, NMDA 1	NMDAR1	N
Glutamate receptor, ionotropic, NMDA 2A	NMDAR2A	N
Glutamate receptor, ionotropic, NMDA 2B	NMDAR2B	N
Glutamate receptor, ionotropic, NMDA 2C	NMDAR2C	N
Glutamate receptor, ionotropic, NMDA 2D	NMDAR2D	N
Glutathione	GSH	T
Glutathione peroxidase, GPX1	GPX1	E
Glutathione S-transferase, GSTZ1	GSTZ1	E
Glyceraldehyde-3-phosphate dehydrogenase, GAPDH	GAPDH	E
Glycerol kinase	GK	E
Glycinamide ribonucleotide (GAR) transformylase	GART	E
Glycine receptor, alpha	GLRA2	N
Glycine receptor, beta		N
Glycine transporter	GLYT	N
Glycogen phosphorylase	PYGL	E
Glycosyltransferases, ABO blood group	ABO	E
GM2 ganglioside activator protein, GM2A	GM2A	E
Green cone pigment	GCP	S
Growth arrest-specific homeobox	GAX	G
Growth factor receptor-bound protein 2	GRB2	G
Growth hormone 1	GH1	G
Growth hormone 2 (placental)	GH2	G

Growth hormone receptor	GHR	G
Growth hormone releasing hormone (GHRH)	GHRH	G
Growth hormone releasing hormone receptor	GHRHR	G
Growth/differentiation factor 5	GDF5	G
GTP cylcohydrolase 1	GCH1	G
GTPase-activating protein, GAP	RASA1	G
Guanidinoacetate N-methyltransferase	GAMT	E
Guanine nucleotide-binding protein, alpha activating activity polypeptide, GNAO	GNAO1	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 1, GNAI1	GNAI1	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 2, GNAI2	GNAI2	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 3, GNAI3	GNAI3	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS1	GNAS1	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS2	GNAS2	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS3	GNAS3	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS4	GNAS4	N
Guanine nucleotide-binding protein, alpha transducing activity polypeptide, GNAT1	GNAT1	N
Guanine nucleotide-binding protein, alpha transducing activity polypeptide, GNAT2	GNAT2	N
Guanine nucleotide-binding protein, beta polypeptide 3	GNB3	N
Guanine nucleotide-binding protein, gamma polypeptide 5	GNG5	N
Guanine nucleotide-binding protein, q polypeptide	GNAQ	N
Guanylate cyclase 2D, membrane (retina-specific)	GUCY2D	E
Guanylate cyclase activator 1A (retina)	GUCA1A	E
H(+), K(+) - ATPase	ATP4B	N
Haeme regulated inhibitor kinase		E
Haemoglobin alpha 1	HBA1	T
Haemoglobin alpha 2	HBA2	T
Haemoglobin beta	HBB	T
Haemoglobin delta	HBD	T
Haemoglobin gamma A	HBG1	T
Haemoglobin gamma B	HBG2	T
Haemoglobin gamma G	HBGG	T
Hairless	HR	G
Heat shock protein, HSP60		I
Heat shock protein, HSP70		I

Heat shock protein, HSP90		I
Heat shock protein, HSPA1		I
Heat shock protein, HSPA2		I
Heparan sulfamidase		E
Heparin binding epidermal growth factor	HBEGF	G
Heparin Cofactor II	HCF2	I
Hepatocyte growth factor	HGF	G
Hermansky-pudlak syndrome gene	HPS	T
Hexokinase 2	HK2	E
Hexosaminidase A	HEXA,TSD	E
Hexosaminidase B	HEXB	E
Histamine receptors, H1		N
Histamine receptors, H2		N
Histamine receptors, H3		N
HLA-B associated transcript 1	BAT1	I
Holocarboxylase synthetase	HLCS	E
Holoprosencephaly 1	HPE1	G
Holoprosencephaly 2	HPE2	G
Holoprosencephaly 3	HPE3	G
Holoprosencephaly 4	HPE4	G
Homeobox (HOX) gene A1	HOXA1	G
Homeobox (HOX) gene A10	HOXA10	G
Homeobox (HOX) gene A11	HOXA11	G
Homeobox (HOX) gene A12	HOXA12	G
Homeobox (HOX) gene A13	HOXA13	G
Homeobox (HOX) gene A2	HOXA2	G
Homeobox (HOX) gene A3	HOXA3	G
Homeobox (HOX) gene A4	HOXA4	G
Homeobox (HOX) gene A5	HOXA5	G
Homeobox (HOX) gene A6	HOXA6	G
Homeobox (HOX) gene A7	HOXA7	G
Homeobox (HOX) gene A8	HOXA8	G
Homeobox (HOX) gene A9	HOXA9	G
Homeobox (HOX) gene B1	HOXB1	G
Homeobox (HOX) gene B2	HOXB2	G
Homeobox (HOX) gene B3	HOXB3	G
Homeobox (HOX) gene B4	HOXB4	G
Homeobox (HOX) gene B5	HOXB5	G
Homeobox (HOX) gene B6	HOXB6	G
Homeobox (HOX) gene B7	HOXB7	G
Homeobox (HOX) gene B8	HOXB8	G
Homeobox (HOX) gene B9	HOXB9	G
Homeobox (HOX) gene C13	HOXC13	G
Homeobox (HOX) gene C4	HOXC4	G
Homeobox (HOX) gene C8	HOXC8	G
Homeobox (HOX) gene C9	HOXC9	G
Homeobox (HOX) gene D1	HOXD1	G
Homeobox (HOX) gene D10	HOXD10	G

Homeobox (HOX) gene D12	HOXD12	G
Homeobox (HOX) gene D13	HOXD13	G
Homeobox (HOX) gene D3	HOXD3	G
Homeobox (HOX) gene D4	HOXD4	G
Homeobox (HOX) gene D8	HOXD8	G
Homeobox (HOX) gene D9	HOXD9	G
Homeobox 11	HOX11	G
Homeobox HB24	HLX1	G
Homeobox HB9	HLXB9	G
Homeobox, PROX1	PROX1	G
Homogentisate 1,2 dioxygenase	HGD	E
Human placental lactogen	CSH1	G
Hypoxia inducible factor 1	HIF1A	E
Hypoxia inducible factor 2		E
IC7 A and B		I
Immunoglobulin E (IgE) responsiveness gene	IGER	I
Indian hedgehog, ihh	IHH	G
Inhibin, alpha	INHA	G
Inhibin, beta A	INHBA	G
Inhibin, beta B	INHBB	G
Inhibin, beta C	INHBC	G
Inositol 1,4,5-triphosphate receptor 3	ITPR3	G
Insulin promotor factor 1	IPF1	G
Insulin-like growth factor 1	IGF1	G
Insulin-like growth factor 1 receptor	IGF1R	G
Insulin-like growth factor 2	IGF2	G
Insulin-like growth factor 2 receptor	IGF2R	G
Integrin beta 1	ITGB1	G
Integrin beta 3	ITGB3	G
Integrin beta 4	ITGB4	G
Integrin, alpha 5	ITGA5	G
Integrin, alpha 7	ITGA7	G
Inter-alpha-trypsin inhibitor, IATI		E
Interferon alpha	IFNA1	I
Interferon beta	IFNB	I
Interferon gamma	IFNG	I
Interferon gamma receptor 1	IFNGR1	I
Interferon gamma receptor 2	IFNGR2	I
Interferon regulatory factor 1	IRF1	I
Interferon regulatory factor 4	IRF4	I
Interleukin(IL) 1 receptor	IL1R	I
Interleukin(IL) 1, alpha	IL1A	I
Interleukin(IL) 1, beta	IL1B	I
Interleukin(IL) 10	IL10	I
Interleukin(IL) 10 receptor	IL10R	I
Interleukin(IL) 11	IL11	I
Interleukin(IL) 11 receptor	IL11R	I
Interleukin(IL) 12	IL12	I

Interleukin(IL) 12 receptor, beta 1	IL12RB1	I
Interleukin(IL) 13	IL13	I
Interleukin(IL) 13 receptor	IL13R	I
Interleukin(IL) 2	IL2	I
Interleukin(IL) 2 receptor, alpha	IL2RA	I
Interleukin(IL) 2 receptor, gamma	IL2RG	I
Interleukin(IL) 3	IL3	I
Interleukin(IL) 3 receptor	IL3R	I
Interleukin(IL) 4	IL4	I
Interleukin(IL) 4 receptor	IL4R	I
Interleukin(IL) 5	IL5	I
Interleukin(IL) 5 receptor	IL5R	I
Interleukin(IL) 6	IL6	I
Interleukin(IL) 6 receptor	IL6R	I
Interleukin(IL) 7	IL7	I
Interleukin(IL) 7 receptor	IL7R	I
Interleukin(IL) 8	IL8	I
Interleukin(IL) 8 receptor	IL8R	I
Interleukin(IL) 9	IL9	I
Interleukin(IL) 9 receptor	IL9R	I
Interleukin(IL) receptor antagonist 1	IL1RN, IL1RA	I
Isocitrate dehydrogenase		E
Kallman syndrome gene 1	KAL1	G
Keratin 1	KRT1	S
Keratin 10	KRT10	S
Keratin 11	KRT11	S
Keratin 12	KRT12	S
Keratin 13	KRT13	S
Keratin 14	KRT14	S
Keratin 15	KRT15	S
Keratin 16	KRT16	S
Keratin 17	KRT17,PCHC1	S
Keratin 18	KRT18	S
Keratin 2	KRT2	S
Keratin 3	KRT3	S
Keratin 4	KRT4	S
Keratin 5	KRT5	S
Keratin 6	KRT6	S
Keratin 7	KRT7	S
Keratin 8	KRT8	S
Keratin 9	KRT9	S
Keratin, hair acidic 1	KRTHA1	S
Keratin, hair basic 2	KRTHB1	S
Keratin, hair basic 6	KRTHB6	S
Kininogen, High molecular weight	KNG	I
Lactate dehydrogenase, A	LDHA	E
Lactate dehydrogenase, B	LDHB	E
Lamin A/C	LMNA	G

Laminin 5, alpha 3	LAMA3	G
Laminin 5, beta 3	LAMB3	G
Laminin 5, gamma 2	LAMC2	G
Laminin M	LAMM	G
Laminin receptor 1	LAMR1	G
Latent transforming growth factor-beta binding protein 2	LTBP2	G
Leukocyte-specific transcript 1	LST-1	I
Leukotriene A4 hydrolase		I
Leukotriene A4 synthase	LTA4S	E
Leukotriene B4 receptor		I
Leukotriene B4 synthase	LTB4S	E
Leukotriene C4 receptor		I
Leukotriene C4 synthase	LTC4S	E
LIM homeobox transcription factor 1, beta	LMX1B	G
Limb girdle muscular dystrophy 1A	LGMD1A	G
Limb girdle muscular dystrophy 1B	LGMD1B	G
Limb girdle muscular dystrophy 2G	LGMD2G	G
Limb girdle muscular dystrophy 2H	LGMD2H	G
Limbic associated membrane protein	LAMP	G
Lipoprotein receptor, Low Density	LDLR	T
Lipoxygenase 12 (platelets)	LOG12	I
Loricrin	LOR	S
Low density lipoprotein receptor-related protein precursor	LRP	T
Luteinizing hormone-releasing hormone		N
Luteinizing hormone-releasing hormone receptor		N
lymphotoxin		I
Lysosome-associated membrane protein 1	LAMP1	G
Lysosome-associated membrane protein 2	LAMP2	G
Lysozyme	LYZ	I
Lysyl hydroxylase	PLOD	E
Lysyl oxidase	LOX	E
Macrophage activating factor	MAF	I
Macrophage inflammatory protein-1	MIP1	I
Macrophage inflammatory protein-1 receptor		I
Macrophage inflammatory protein-2	MIP2	I
Macrophage inflammatory protein-2 receptor		I
MADS box transcription-enhancer factor 2A	MEF2A	G
MADS box transcription-enhancer factor 2B	MEF2B	G
MADS box transcription-enhancer factor 2C	MEF2C	G
MADS box transcription-enhancer factor 2D	MEF2D	G
Mannose binding protein	MBP	I
Mannosidase, alpha B lysosomal	MANB	E
Mannosidase, beta A lysosomal	MANBA	E
Marenostrin	MEFV	T
Matrix Gla protein	MGP	G

Matrix metalloproteinase 1	MMP1	E
Matrix metalloproteinase 10	MMP10	E
Matrix metalloproteinase 11	MMP11	E
Matrix metalloproteinase 12	MMP12	E
Matrix metalloproteinase 13	MMP13	E
Matrix metalloproteinase 14	MMP14	E
Matrix metalloproteinase 15	MMP15	E
Matrix metalloproteinase 16	MMP16	E
Matrix metalloproteinase 17	MMP17	E
Matrix metalloproteinase 18	MMP18	E
Matrix metalloproteinase 19	MMP19	E
Matrix metalloproteinase 2	MMP2	E
Matrix metalloproteinase 3	MMP3, STMY1	E
Matrix metalloproteinase 4	MMP4	E
Matrix metalloproteinase 5	MMP5	E
Matrix metalloproteinase 6	MMP6	E
Matrix metalloproteinase 7	MMP7	E
Matrix metalloproteinase 8	MMP8	E
Matrix metalloproteinase 9	MMP9	E
MEK kinase, MEKK		E
Melanocortin 1 receptor	MC1R	T
Melanocortin 2 receptor	MC2R	T
Melanocortin 4 receptor	MC4R	T
Mesoderm-specific transcript	MEST	G
Methylguanine-DNA methyltransferase	MGMT	E
Methylmalonyl-CoA mutase	MUT	E
Mevalonate kinase	MVK	E
MHC Class I: A		I
MHC Class I: B		I
MHC Class I: C		I
MHC Class I: LMP-2, LMP-7		I
MHC Class I: Tap1	ABCR, TAP1	I
MHC Class II: DP	HLA-DPB1	I
MHC Class II: DQ		I
MHC Class II: DR		I
MHC Class II: Tap2	TAP2, PSF2	I
MHC Class II:Complementation group A	MHC2TA	I
MHC Class II:Complementation group B	rfxank	I
MHC Class II:Complementation group C	RFX5	I
MHC Class II:Complementation group D	RFXAP	I
Microphthalmia-associated transcription factor	MITF	G
Midline 1	MID1	G
Mitochondrial trifunctional protein, alpha subunit	HADHA	E
Mitochondrial trifunctional protein, beta subunit	HADHB	E
Moesin, MSN		S

reductase		
NB6		I
Nebulin	NEB	S
Nephrosis 1	NPHS1	T
Neural retina-specific gene	NRL	G
Neuraminidase sialidase	NEU	T
Neuregulin	HGL	G
Neurexin		N
Neuroendocrine convertase 1	NEC1, PCSK1	E
Neurokinin A	NKNA	N
Neurokinin B	NKNB	N
Neuropeptide Y	NPY	N
Neuropeptide Y receptor Y1	NPY1R	N
Neuropeptide Y receptor Y2	NPY2R	N
Neurotensin	NTS	N
Neurotensin receptor	NTSR1	N
Nibrin	NBS1	G
Noggin	NOG	G
Notch ligand - jagged 1	JAG1, AGS	G
Nuclear factor I-kappa-B-like gene	IKBL	I
Nuclear factor kappa beta	NFKB	I
Nuclear factor of activated T cells (NFAT)	NFATC	G
complex, cytosolic		
Nuclear factor of activated T cells (NFAT)	NFATP	G
complex, preexisting component		
Ocular albinism 1	OA1	S
Oculocutaneous albinism II	OCA2	S
Oncogene ERG (early reponse gene)		G
Oncogene fos	FOS	G
Oncogene GLI1	GLI	G
Oncogene GLI2	GLI2	G
Oncogene GLI3	GLI3	G
Oncogene sis	PDGFB	G
Oncogene src		G
Opioid receptor, delta	OPRD1	N
Opioid receptor, kappa	OPRK1	N
Opioid receptor, mu	OPRM1	N
Ornithine delta-aminotransferase	OAT	E
Osteocalcin		S
Osteonectin	ON	G
Osteopontin	OPN	G
Osteoprotegerin	OPG	G
Oxytocin	OXT	N
Oxytocin receptor	OXTR	N
p21-activated kinase 3	PAK3	G
Paired box homeotic gene 1	PAX1	G
Paired box homeotic gene 2	PAX2	G
Paired box homeotic gene 3	PAX3	G



Paired box homeotic gene 6	PAX6	G
Paired box homeotic gene 7	PAX7	G
Paired box homeotic gene 8	PAX8	G
Paired-like homeodomain transcription factor 2	PITX2	G
Paired-like homeodomain transcription factor 3	PITX3	G
Parathyroid hormone	PTH	G
Parathyroid hormone receptor	PTHrP	G
Parathyroid hormone related-peptide	PTHrP	G
Parathyroid hormone-like hormone	PTHrP	G
Patched (Drosophila) homolog, PTCH	PTCH	G
Peanut-like 1	PNUTL1	I
Peripherin, PRPH		S
Peroxisomal membrane protein 1	PXMP1	S
Peroxisomal membrane protein 3	PXMP3	T
Peroxisome biogenesis factor 1	PEX1	T
Peroxisome biogenesis factor 19	PEX19	T
Peroxisome biogenesis factor 6	PEX6	T
Peroxisome biogenesis factor 7	PEX7	T
Peroxisome receptor 1	PXR1	T
Phenylethanolamine N-methyltransferase, PNMT	PNMT	E
Phosphate regulating gene with homologies to endopeptidases on the X chromosome	PHEX	G
Phosphodiesterase 1 / nucleotide pyrophosphatase 1	PDNP1	G
Phosphodiesterase 1 / nucleotide pyrophosphatase 2	PDNP2	G
Phosphodiesterase 1 / nucleotide pyrophosphatase 3	PDNP3	G
Phosphofructokinase, muscle	PFKM	E
Phosphoglucose isomerase	GPI	E
Phosphoglycerate kinase 1	PGK1	E
Phosphoglycerate mutase 2	PGAM2	E
Phospholipase A2, group 10	PLA2G10	I
Phospholipase A2, group 1B	PLA2G1B	I
Phospholipase A2, group 2A	PLA2G2A	I
Phospholipase A2, group 2B	PLA2G2B	I
Phospholipase A2, group 4A	PLA2G4A	I
Phospholipase A2, group 4C	PLA2G4C	I
Phospholipase A2, group 5	PLA2G5	I
Phospholipase A2, group 6	PLA2G6	I
Phosphomannomutase 2	PMM2	G
Phosphoribosyl pyrophosphate synthetase	PRPS1	E
Phosphorylase kinase, alpha 1 (muscle)	PHKA1	E
Phosphorylase kinase, beta	PHKB	E
Phosphorylase kinase, delta		E

Phosphorylase kinase, gamma 2	PHKG2	E
Phytanoyl-CoA hydroxylase	PHYH	G
Pineolytic beta-receptors		E
Plakophilin 1	PKP1	T
Plasminogen	PLG	E
Platelet derived growth factor	PDGF	G
Platelet derived growth factor receptor	PDGFR	G
Plectin 1	PLEC1	T
Potassium inwardly-rectifying channel J1	KCNJ1	N
Potassium voltage-gated channel E1	KCNE1	N
Potassium voltage-gated channel Q1	KCNQ1	N
Potassium voltage-gated channel Q2	KCNQ2	N
Potassium voltage-gated channel Q3	KCNQ3	N
POU domain, class 3, transcription factor 4	POU3F4	G
POU domain, class 4, transcription factor 3	POU4F3	G
Prion protein	PRNP	N
Procollagen N-protease		E
Procollagen peptidase		E
Prodynorphin		N
Profibrinolysin		G
Progesterone receptor (RU486 binding receptor)	PGR	G
Prolactin receptor	PRLR	G
Prolactin releasing hormone	PRH	G
Proliferin	PLF	G
Proopiomelanocortin	POMC	N
Properdin P factor, complement	PFC, PFD	I
Prophet of Pit1	PROP1	G
Propionyl-CoA carboxylase, alpha	PCCA	E
Prosaposin	PSAP	N
Prostacyclin synthase		I
Prostaglandin 15-OH dehydrogenase	HGPD; PGDH	I
Prostaglandin D - DP receptor		I
Prostaglandin E1 receptor		I
Prostaglandin E2 receptor		I
Prostaglandin E3 receptor		I
Prostaglandin F - FP receptor		I
Prostaglandin F2 alpha receptor		I
Prostaglandin I2 receptor		T
Prostaglandin IP receptor		I
Prostaglandin isomerase		G
Protease nexin 2	PN2	E
Protective protein for beta-galactosidase	PPGB	E
Protein C	PROC	I
Proteinase 3		I
Purine nucleoside phosphorylase	NP	E
Purinergic receptor P1A1		N
Purinergic receptor P1A2		N

Purinergic receptor P1A3		N
Purinergic receptor P2X, 1	P2RX1	N
Purinergic receptor P2X, 2	P2RX2	N
Purinergic receptor P2X, 3	P2RX3	N
Purinergic receptor P2X, 4	P2RX4	N
Purinergic receptor P2X, 5	P2RX5	N
Purinergic receptor P2X, 6	P2RX6	N
Purinergic receptor P2X, 7	P2RX7	N
Purinergic receptor P2Y, 1	P2RY1	N
Purinergic receptor P2Y, 11	P2RY11	N
Purinergic receptor P2Y, 2	P2RY2	N
Pyrroline-5-carboxylate synthetase	PYCS	E
Pyruvate kinase	PKLR	E
Rabphilin		N
Radixin	RDX	S
RAS-associated protein, RAB3A	RAB3A	N
Rathke pouch homeobox, RPX	RPX	G
Receptor tyrosine kinase (RTK), Nsk2	NSK2	G
Retinal pigment epithelium specific protein (65kD)	RPE65	S
Retinitis pigmentosa gene 1	RP1	S
Retinitis pigmentosa gene 2	RP2	S
Retinitis pigmentosa gene 3	RP3	S
Retinitis pigmentosa gene 6	RP6	S
Retinitis pigmentosa gene 7	RP7, RDS	S
Retinoblastoma 1	RB1	G
Retinoic acid receptor, alpha	RARA	G
Retinoic acid receptor, beta	RARB	G
Retinoic acid receptor, gamma	RARG	G
Retinoid X receptor, alpha	RXRA	G
Retinoid X receptor, beta	RXRB	G
Retinoid X receptor, gamma	RXRG	G
Retinol binding protein 4	RBP4	T
Rhodopsin	RHO	S
RIGUI	RIGUI	G
Rim		N
Rod outer segment membrane protein 1	ROM1	S
Ryanodine receptor 1, skeletal	RYSR1	G
Serotonin N-acetyltransferase	SNAT	E
Serotonin receptor, 5HT1A	HTR1A	N
Serotonin receptor, 5HT1B	HTR1B	N
Serotonin receptor, 5HT1C	HTR1C	N
Serotonin receptor, 5HT1D	HTR1D	N
Serotonin receptor, 5HT1E	HTR1E	N
Serotonin receptor, 5HT1F	HTR1F	N
Serotonin receptor, 5HT2A	HTR2A	N
Serotonin receptor, 5HT2B	HTR2B	N
Serotonin receptor, 5HT2C	HTR2C	N

Serotonin receptor, 5HT3	HTR3	N
Serotonin receptor, 5HT4	HTR4	N
Serotonin receptor, 5HT5	HTR5	N
Serotonin receptor, 5HT6	HTR6	N
Serotonin receptor, 5HT7	HTR7	N
Sex hormone binding globulin, SHBG		T
Sialoprotein, bone	BSP	G
Signal transducer and activator of transcription 1	STAT1	G
Signaling lymphocyte activation molecule	SLAM	I
Sine oculis homeobox, drosophila, homolog 1	SIX1	G
Sine oculis homeobox, drosophila, homolog 2	SIX2	G
Sine oculis homeobox, drosophila, homolog 5	SIX5	G
Sjogren (Sjogren) syndrome antigen A1	SSA1	I
Slug protein		G
Small nuclear ribonucleoprotein polypeptide N	SNRPN	S
Smoothelin	SMTN	G
Smoothed (Drosophila) homolog	SMOH	G
Sodium channel, non-voltage gated 1, alpha	SCNN1A	N
Sodium channel, non-voltage gated 1, beta	SCNN1B	N
Sodium channel, non-voltage gated 1, gamma	SCNN1G	N
Sodium channel, voltage gated, type IV, alpha polypeptide	SCN4A	N
Sodium channel, voltage gated, type V, alpha polypeptide	SCN5A	N
Sodium channel, voltage-gated, type 1, beta polypeptide	SCN1B	N
Solute carrier family 1 (glutamate transporter), member 1	SLC1A1	T
Solute carrier family 1 (glutamate transporter), member 2	SLC1A2	T
Solute carrier family 12, member 1	SLC12A1	T
Solute carrier family 12, member 2	SLC12A2	T
Solute carrier family 12, member 3	SLC12A3	T
Solute carrier family 16 (monocarboxylate transporter), member 1	SLC16A1	T
Solute carrier family 16 (monocarboxylate transporter), member 7	SLC16A7	T
Solute carrier family 17, member 1	SLC17A1	T
Solute carrier family 17, member 2	SLC17A2	T
Solute carrier family 19 (folate transporter), member 1	SLC19A1	T
Solute carrier family 21, member 2	SLC21A2	T
Solute carrier family 21, member 3	SLC21A3	T
Solute carrier family 25, member 12	SLC25A12	T
Solute carrier family 6 (GAMMA-	SLC6A1	T

## AMINOBTYRIC ACID transporter), member

1

Solute carrier family 6 (neurotransmitter transporter, dopamine), member 3	SLC6A3	T
Solute carrier family 6 (neurotransmitter transporter, noradrenaline), member 2	SLC6A2	T
Solute carrier family 6, member 10	SLC6A10	T
Solute carrier family 6, member 8	SLC6A8	T
Solute carrier family 7(amino acid transporter), member 1	SLC7A1	T
Solute carrier family 7(amino acid transporter), member 2	SLC7A2	T
Solute carrier family 7(amino acid transporter), member 7	SLC7A7	T
Solute carrier family 8 (sodium/calcium exchanger), member 1	SLC8A1	T
Somatostatin	SST	N
Somatostatin receptor, SSTR1	SSTR1	N
Somatostatin receptor, SSTR2	SSTR2	G
Somatostatin receptor, SSTR3	SSTR3	N
Somatostatin receptor, SSTR4	SSTR4	N
Somatostatin receptor, SSTR5	SSTR5	N
Sonic hedgehog, SHH	SHH	G
Sorbitol dehydrogenase	SORD	E
Sorcin	SRI	T
Spectrin alpha	SPTA1	S
Spectrin beta	SPTB	S
Sperm adhesion molecule	SPAM1	G
Sperm protamine P1	PRM1	G
Sperm protamine P2	PRM2	G
Sphingomyelinase	SMPD1	E
Split hand/foot malformation gene	DSS1	G
SRY-box 10	SOX10	G
SRY-box 11	SOX11	G
SRY-box 3	SOX3	G
SRY-box 4	SOX4	G
SRY-box 9	SOX9	G
Steroid 5 alpha reductase 1	SRD5A1	E
Steroid 5 alpha reductase 2	SRD5A2	E
Steroid sulphatase	STS	E
Substance P		N
Succinate dehydrogenase 1	SDH1	E
Succinate dehydrogenase 2	SDH2	E
Sulfamidase	SGSH	G
Superoxide dismutase 1	SOD1	E
Superoxide dismutase 3	SOD3	E
Survival of motor neuron 1, telomeric	SMN1	T
Synapsin 1a & 1b	SYN1	N

Synapsin 2a & 2b	SYN2	N
Synaptic vesicle protein 2	SV2	N
Synaptobrevin 1	SYB1	N
Synaptobrevin 2	SYB2	N
Synaptogyrin		N
Synaptophysin	SYP	N
Synaptosomal-associated protein, 25KD	SNAP25	N
Synaptotagmin 1	SYT1	N
Synaptotagmin 2	SYT2	N
Synovial sarcoma gene 1	SSX1	G
Synovial sarcoma gene 2	SSX2	G
Syntaxin 1	STX1	N
Tachykinin receptor, NK1R	TACR1	N
Tachykinin receptor, NK2R	TACR2	N
Tachykinin receptor, NK3R	TACR3	N
Talin, TLN		S
T-BOX 1	TBX1	G
T-BOX 2	TBX2	G
T-BOX 3	TBX3	G
T-BOX 4	TBX4	G
T-BOX 5	TBX5	G
T-BOX 6	TBX6	G
TEK, tyrosine kinase, endothelial	TEK	E
Telomerase protein component		E
Tetranectin	TNA	T
Thrombospondin	THBS1	G
Thromboxane A synthase 1	TBXAS1	I
Thromboxane A2	TXA2	I
Thromboxane A2 receptor	TBXA2R	I
Thymosin		I
Thyrotropin releasing hormone	TRH	N
Thyrotropin releasing hormone	TRH	G
Thyrotropin releasing hormone receptor	TRHR	N
Tip-associated protein	TAP	I
Tissue non-specific alkaline phosphatase		E
TNSAP		
Titin	TTN	S
Tocopherol (alpha) transfer protein	TTPA	T
Torticollis, keloids, cryptorchidism and renal dysplasia gene	TKCR	G
Transforming growth factor, alpha	TGFA	G
Transforming growth factor, beta 2	TGFB2	G
Transforming growth factor, beta induced	TGFB1	G
Transforming growth factor, beta receptor 2	TGFB2R	G
Transglutaminase 1	TGM1	G
Transglutaminase 2	TGM2	G
Transglutaminase 4	TGM4	G
Transthyretin	TTR	T

Treacle gene	TCOF1	G
Triosephosphate isomerase	TPI1	E
Tropomyosin 1 alpha	TPM1	S
Tropomyosin 3 (non-muscle)	TPM3	S
Troponin C		S
Troponin I	TNNI3	S
Troponin T2, cardiac	TNNT2	S
Trypsinogen 1	TRY1	E
Trypsinogen 2	TRY2	E
Tubby-like protein 1	TULP1	G
Tuberous sclerosis 1	TSC1	G
Tuberous sclerosis 2	TSC2	G
Tumor susceptibility gene 101	TSG101	G
Tumour necrosis factor (TNF) receptor associated factor 1	TRAF1	I
Tumour necrosis factor (TNF) receptor associated factor 2	TRAF2	I
Tumour necrosis factor (TNF) receptor associated factor 3	TRAF3	I
Tumour necrosis factor (TNF) receptor associated factor 4	TRAF4	I
Tumour necrosis factor (TNF) receptor associated factor 5	TRAF5	I
Tumour necrosis factor (TNF) receptor associated factor 6	TRAF6	I
Tumour necrosis factor alpha	TNFA	I
Tumour necrosis factor alpha receptor	TNFAR	I
Tumour necrosis factor beta	TNFB	I
Tumour necrosis factor beta receptor	TNFBR	I
Tumour protein p53	TP53, P53	G
Tumour protein p63	TP63	G
Tumour protein p73	TP73	G
Tumour protein, translationally-controlled 1	TPT1	G
Tumour suppressor gene DRA	DRA	I
Tyrosinase	TYR	E
Tyrosinase-related protein 1	TYRP1	E
Tyrosine aminotransferase	TAT	E
Ubiquitin activating enzyme, E1		E
Ubiquitin protein ligase E3A	UBE3A	E
Uncoupling protein 3	UCP3	T
Undulin 1	COL14A1	S
Uroporphyrinogen decarboxylase	UROD	E
Usher syndrome 2A	USH2A	S
Vacuolar proton pump, subunit 1	VPP1	N
Vacuolar proton pump, subunit 3	VPP3	N
Vascular endothelial growth factor	VEGF	G
Vasoactive intestinal polypeptide	VIP	N
Vasoactive intestinal polypeptide receptor	VIPR	N

Villin		S
Vinculin		S
Vitamin D receptor	VDR	G
Vitelliform macular dystrophy, atypical gene	VMD1	T
Von Hippel-Lindau gene	VHL	G
Von Willebrand factor	VWF	T
Werner syndrome helicase	WRN	G
Winged helix nude	WHN	G
Wingless family, wnt2	WNT2	G
Wingless family, wnt4	WNT4	G
Wingless family, wnt5	WNT5	G
Wingless family, wnt7	WNT7	G
Wingless family, wnt8	WNT8	G
Wiskott-Aldrich syndrome protein	WASP, THC	I
Wnt inhibitory factor, WIF-1	WIF1	G
Wolf-Hirschhorn syndrome candidate 1 gene	WHSC1	G
Wolfram syndrome 1 gene	WFS1	S
Xeroderma pigmentosum, complementation group A	XPA	E
Xeroderma pigmentosum, complementation group B	XPB	E
Xeroderma pigmentosum, complementation group C	XPC	E
Xeroderma pigmentosum, complementation group D		E
Xeroderma pigmentosum, complementation group E		E
Xeroderma pigmentosum, complementation group F	XPF	E
Xeroderma pigmentosum, complementation group G	ERCC5	E
X-ray repair gene	XRCC9	G



In a fourteenth aspect.

## METABOLIC AND ENDOCRINE FUNCTIONS, DISORDERS AND DISEASE PATENT APPLICATION

This invention relates to method of assessing the risk of developing the clinical or social consequences of a metabolic or endocrine disorder or disease and indicating appropriate therapeutic interventions.

Cellular physiology is regulated by a complex series of interactions between molecules, which are referred to collectively as metabolism (Stryer 1995).

Metabolism concerns the two central processes of how cells:

- extract energy from their environment
- synthesise and process the molecules required to maintain their function.

The number of molecular interactions taking place within a given cell is enormous and the overall complexity appears daunting. However, decades of study have shown that whilst the overall number of molecular interactions is very great, the types of interactions which molecules experience is finite. There are four major classes of biological molecules; carbohydrates, nucleic acids, lipids and proteins.

The core processes of metabolism can be condensed into a series of statements concerning the overall strategy used (Stryer 1995):

- ATP is the universal currency of energy;
- ATP is generated by the oxidation of fuel molecules such as glucose, fatty acids and amino acids,
- NADPH is the major electron donor in reductive biosyntheses,
- Biomolecules are constructed from a small set of building blocks,
- Biosynthetic and degradative pathways are almost always distinct.

The orchestration and co-ordination of this strategy for life is controlled largely by the allosteric interactions and reversible covalent modification of enzymes, by altered expression patterns and levels of key enzymes and by the compartmentation of different patterns of enzyme activity within the cell.

In human physiology a further dimension of complexity is added by the fact that different organs will have different metabolic roles and that a further system – the endocrine system- has evolved in order to integrate metabolism across the whole body.

The endocrine system is a diverse group of specialised tissues –glands- that secrete substances called hormones directly into the blood. The blood transports hormones to other organs or organelles where they interact with specific receptor sites and thus signal changes in cellular activities (e.g. glucocorticoids act to regulate immune system activities such as leucocyte movement or antigen processing). Hormonal secretion is variable and is controlled or prompted by the physiological demands of the body.

Principal endocrine glands include the following;

Brain  
Pituitary  
Pineal  
Thyroid  
Parathyroid  
Adrenal  
Pancreas  
Ovary  
Testes  
Gastrointestinal Tract  
Kidney  
Thymus  
Placenta

Each of these tissues manufacture and release hormones. Hormones can be classified according to their mode of targeting their sites of action;

Autocrine – acting on the same cells that manufacture them (e.g. IGF-1).

Paracrine – acting on neighbouring or distant cells separated by the extracellular space (e.g. insulin).

Endocrine – acting on cells or organs at distant sites and travelling in the blood stream or lymph (e.g. sex hormones)

Neuroendocrine – site of manufacture is within a neurone (e.g. GnRH).

Neural – synthesised in a neurone and released to act on an adjacent neurone (i.e. neurotransmitters such as acetylcholine).

Pheromonal – release of volatile hormones into the atmosphere where they can be detected by another individual.

Whatever the mechanism of release and travel to the target tissue, hormones act through specific receptors to generate selectivity of response in the target tissue. Charged molecules such as peptides generally bind to cell surface receptors and affect cell function by triggering secondary messenger systems (e.g. G proteins, tyrosine kinases). Uncharged molecules such as steroid hormones diffuse into cells and bind to receptor proteins which can be in the cytoplasm or the nucleus (e.g. heat shock protein –HSP90). The hormone-receptor complex can then be transported into the nucleus in order to bind to DNA and affect rates of protein transcription and the metabolic activity of cells.

The interaction between metabolism and endocrine regulation is a key event for the maintenance of homeostasis – the ability to maintain a stable body environment despite changes in the external environment. Integration of the body systems is achieved through a series of regulatory systems which utilise negative and positive feedback mechanisms (systems limit each others' activity within certain parameters) in order to maintain homeostasis.

The critical role of proteins (e.g. as enzymes or transporters in metabolism or hormones in the endocrine system) and the presence of multiple regulatory loops linking the various metabolic and endocrine activities ensures that variability in the functionality of particular proteins can lead to profound clinical consequences.

Genetic variation in genes coding for proteins involved in metabolic or endocrine function can lead to the production of defective enzymes or altered receptor binding affinities. In cystinuria there is a defective transport of cystine, lysine, ornithine, arginine and homoarginine across the epithelium of the small intestine due to a defective protein. In Tay-Sachs disease there is defective processing of hexosaminidase-A leading to gangliosidosis.

The range of clinical manifestations of metabolic and endocrine damage dysfunction or disease is very wide (Weatherall, Ledingham and Warrell 1996) and spans failure to thrive in infancy to infertility problems to dementia.

The range of potential therapeutic interventions is also wide, from simple dietary controls (e.g. phenylketonuria) to liver transplantation (e.g. galactosaemia) and gene therapy (e.g. cystic fibrosis).

Metabolism and endocrine status has important implications for therapeutic interventions and particularly drug usage. Body height and weight is one of the critical parameters in calculating drug dosage. Malnourished patients can have aberrant electrolyte balances conferring significant cardiovascular risks with certain drugs such as cholinergic or adrenergic agonists and calcium channel blockers. Obesity also affects the distribution of lipophilic drugs through the body and the metabolism of many drugs will be affected by the presence of food in the gastrointestinal tract (Brody, Larner, Minneman 1998). Meals can also alter the physiology of the body by inducing vasoconstriction or enhanced metabolism in various organs.

Alterations in endocrine status caused by either changes in physiological state, injury or disease (e.g. pregnancy, diabetes, pituitary tumors) are known to have a profound affect on health and response to disease and therapeutic interventions (Weatherall, Ledingham and Warrell 1996, Brody, Larner and Minneman 1998).

The physiology and control of the body's metabolic and endocrine systems is extremely complex and involves the synergistic or inhibitory interaction between multiple regulatory pathways and molecular cascades. Variation in the functionality of the proteins involved in these processes will, inevitably, cause or have an impact on the functioning of these systems or an individual's attempts to minimise damage and restore function following dysfunction, damage or disease in these systems. A number of constitutional factors are known to impact on the individual's ability to deal with and recover from infection and injury including genetic history, age, sex, nutritional status, pre-existing disease or injury and drug treatments. Genetic variation within individuals is also a key factor although the extent and nature of the genes involved and their precise impact on prognosis, complications, efficacy of therapeutic intervention and eventual recovery of function is largely unknown.

The individual variability in response to damage, dysfunction or disease affecting the metabolic or endocrine systems and the associated variation in symptomatology, response to therapy and adverse events resulting from therapeutic interventions lies at

the heart of the difficulties experienced in the healthcare and social management of metabolic and endocrine damage, dysfunction or disease.

We have elaborated on the value and utility to be derived from the gathering together of the genes which form the core gene list for this particular Genostic system.

These genes are elaborated below:

#### KEY TO 'PROTEIN FUNCTION' COLUMN

E ENZYME  
T TRANSPORT & STORAGE  
S STRUCTURAL  
I IMMUNITY  
N NERVOUS TRANSMISSION  
G GROWTH & DIFFERENTIATION

METABOLIC & ENDOCRINE GENE LIST	HUGO gene symbol	Protein function
17beta hydroxysteroid dehydrogenase 1	HSD17B1	E
17beta hydroxysteroid dehydrogenase 3	HSD17B3	E
17beta hydroxysteroid dehydrogenase 4	HSD17B4	E
17beta hydroxysteroid oxidoreductase		E
17-ketosteroid reductase		N
18-hydroxysteroid oxidoreductase		E
2,3-bisphosphoglycerate mutase	BPGM	E
2,4-dienoyl CoA reductase	DECR	E
3 beta hydroxysteroid dehydrogenase 2	HSD3B2	E
3-oxoacid CoA transferase	OXCT	E
5-adenosyl homocysteine hydrolase		E
6-phosphofructo-2-kinase	PFKFB1	E
6-pyruvoyltetrahydropterin synthase	PTS	E
Acetoacetyl 1-CoA-thiolase	ACAT1	E
Acetyl CoA acyltransferase	ACAA	E
Acetyl CoA carboxylase	ACC	E
Acetyl CoA carboxylase alpha	ACACA	E
Acetylcholinesterase	ACHE	E
Acid phosphatase 2, lysosomal	ACP2	E
Actin, alpha, cardiac	ACTC	S
Actin, alpha, skeletal	ACTA1	S
Actin, alpha, smooth, aortic	ACTA2	S
Activin		G
Activin A receptor, type 2B	ACVR2B	G
Activin A receptor, type 2-like kinase 1	ACVRL1	G
Acyl CoA dehydrogenase, long chain	ACADL	E
Acyl CoA dehydrogenase, medium chain	ACADM	E
Acyl CoA dehydrogenase, short chain	ACADS	E
Acyl CoA dehydrogenase, very long chain	ACADVL	E

Acyl CoA synthetase, long chain, 1	LACS1	E
Acyl CoA synthetase, long chain, 2	LACS2	E
Acyl CoA synthetase, long chain, 4	ACS4	E
Acyl malonyl condensing enzyme		E
Adenomatous polyposis coli tumour supressor gene	APC	G
Adenosine deaminase	ADA	E
Adenosine monophosphate deaminase	AMPD	E
Adenosine receptor A1	ADORA1	N
Adenosine receptor A2A	ADORA2A	N
Adenosine receptor A2B	ADORA2B	N
Adenosine receptor A3	ADORA3	N
Adenyl cyclase		N
Adenylate cyclase 1	ADCY1	E
Adenylate cyclase 2	ADCY2	E
Adenylate cyclase 3	ADCY3	E
Adenylate cyclase 4	ADCY4	E
Adenylate cyclase 5	ADCY5	E
Adenylate cyclase 6	ADCY6	E
Adenylate cyclase 7	ADCY7	E
Adenylate cyclase 8	ADCY8	E
Adenylate cyclase 9	ADCY9	E
Adenylate transferase		E
ADP-ribosyltransferase	ADPRT	E
Adrenergic receptor, alpha1	ADRA1	N
Adrenergic receptor, alpha2	ADRA2	N
Adrenergic receptor, beta1	ADRB1	N
Adrenergic receptor, beta2	ADRB2	N
Adrenergic receptor, beta3	ADRB3	N
Adrenoleukodystrophy gene	ALD	E
Albumin, ALB	ALB	T
Alcohol dehydrogenase 1	ADH1	E
Alcohol dehydrogenase 2	ADH2	E
Alcohol dehydrogenase 3	ADH3	E
Alcohol dehydrogenase 4	ADH4	E
Alcohol dehydrogenase 5	ADH5	E
Alcohol dehydrogenase 6	ADH6	E
Alcohol dehydrogenase 7	ADH7	E
Aldehyde dehydrogenase 1	ALDH1	E
Aldehyde dehydrogenase 10	ALDH10	E
Aldehyde dehydrogenase 2	ALDH2	E
Aldehyde dehydrogenase 5	ALDH5	E
Aldehyde dehydrogenase 6	ALDH6	E
Aldehyde dehydrogenase 7	ALDH7	E
Aldolase A	ALDOA	E
Aldolase B	ALDOB	E
Aldolase C	ALDOC	E
Aldosterone receptor	MLR	G

Alkaline phosphatase, liver/bone/kidney	ALPL	T
Alkylglycerone phosphate synthase	AGPS	E
Alpha 1 acid glycoprotein	AAG; AGP	T
alpha1-antitrypsin	PI	E
alpha-actinin 2	ACTN2	G
alpha-actinin 3	ACTN3	G
alpha-amino adipic semialdehyde synthase		E
alpha-glucosidase, neutral AB	GANAB	E
alpha-glucosidase, neutral C	GANC	E
alpha-ketoglutarate dehydrogenase		E
Aminomethyltransferase	AMT	E
Aminopeptidase P	XPNPEP2	E
Amphiregulin	AREG	G
Amylo-1,6-glucosidase	AGL	E
Androgen receptor	AR	G
Angiopoietin 1	ANGPT1	G
Angiopoietin 2	ANGPT2	G
Angiotensin converting enzyme	ACE, DCP1	E
Angiotensin receptor 1	AGTR1	T
Angiotensin receptor 2	AGTR2	T
Angiotensinogen	AGT	E
Anti-Mullerian hormone	AMH	G
Anti-Mullerian hormone type 2 receptor	AMHR2	G
Apolipoprotein A I	APOA1	T
Apolipoprotein A II	APOA2	T
Apolipoprotein B	APOB	T
Apolipoprotein C1	APOC1	T
Apolipoprotein C2	APOC2	T
Apolipoprotein C3	APOC3	T
Apolipoprotein D	APOD	T
Apolipoprotein E	APOE	T
Apolipoprotein H	APOH	T
Aquaporin 1	AQP1	T
Aquaporin 2	AQP2	T
Arginine vasopressin	AVP	N
Arginine vasopressin receptor 1A	AVPR1A	N
Arginine vasopressin receptor 1B	AVPR1B	N
Arginine vasopressin receptor 2	AVPR2	N
Asparagine synthetase	AS	E
Aspartate transcarbamoylase		E
Ataxia telangiectasia complementation group D	ATD, ATDC	G
Ataxia telangiectasia gene, AT	ATM	G
ATP cobalamin adenosyltransferase		E
Atrial natriuretic peptide	ANP	G
Atrial natriuretic peptide receptor A	NPR1	G
Atrial natriuretic peptide receptor B	NPR2	G
Atrial natriuretic peptide receptor C	NPR3	G

Attractin		I
Autoimmune regulator, AIRE	AIRE	I
beta-endorphin receptor		N
beta-galactosidase	GLB1	E
beta-ketoacyl reductase		E
Bile acid coenzyme A: amino acid N-acyltransferase	BAAT	E
Bile salt export pump	BSEP, PFIC2	T
Bile salt-stimulated lipase	CEL	E
Bilirubin UDP-glucuronosyltransferase		E
Bloom syndrome protein	BLM	G
Bradykinin receptor B1		I
Bradykinin receptor B2		I
Branched chain aminotransferase 1, cytosolic	BCAT1	E
Branched chain aminotransferase 2, mitochondrial	BCAT2	E
Branched chain keto acid dehydrogenase E1, alpha polypeptide		E
Branched chain keto acid dehydrogenase E1, beta polypeptide		E
Butyrylcholinesterase	BCHE	E
C17-20 desmolase		E
C3 convertase		E
Calbindin 1	CALB1	G
Calbindin D9K	CALB3	G
Calcineurin A1	CALNA1	I
Calcineurin A2	CALNA2	I
Calcineurin A3	CALNA3	I
Calcineurin B		I
Calcitonin receptor /Calcitonin gene-related peptide receptor	CALCR	N
Calcitonin/Calcitonin gene-related peptide alpha	CALCA	N
Calcium channel, voltage-dependent, alpha 1F subunit	CACNA1F	N
Calcium channel, voltage-dependent, Alpha-1B (CACNL1A5)	CACNA1B	N
Calcium channel, voltage-dependent, Alpha-1C	CACNA1C	N
Calcium channel, voltage-dependent, Alpha-1D	CACNA1D	N
Calcium channel, voltage-dependent, Alpha-1E (CACNL1A6)	CACNA1E	N
Calcium channel, voltage-dependent, Alpha-2/delta	CACNA2	N
Calcium channel, voltage-dependent, Beta 1	CACNB1	N
Calcium channel, voltage-dependent, Beta 3	CACNB3	N
Calcium channel, voltage-dependent, L type,	CACNA1S	N

alpha 1S subunit		
Calcium channel, voltage-dependent, Neuronal, Gamma	CACNG2	N
Calcium channel, voltage-dependent, P/Q type, alpha 1A subunit	CACNA1A	N
Calcium channel, voltage-dependent, T-type		N
Calcium sensing receptor	CASR	T
Calmodulin 1	CALM1	G
Calmodulin 2	CALM2	G
Calmodulin 3	CALM3	G
Calmodulin-dependant protein kinase II	CAMK2A	G
Calnexin	CANX	G
Calpain	CAPN, CAPN3	E
Calretinin	CALB2	N
Canalicular multispecific organic anion transporter	CMOAT	T
Cannabinoid receptor	CNR1	N
Carbonic anhydrase 3	CA3	E
Carbonic anhydrase 4	CA4	E
Carbonic anhydrase, alpha	CA1	E
Carbonic anhydrase, beta	CA2	E
Carboxylesterase 1	CES1	E
Cardiac-specific homeobox, CSX	CSX	G
Carnitine acetyltransferase	CRAT	E
Carnitine acylcarnitine translocase	CACT	E
Carnitine palmitoyltransferase I	CPT1A	E
Carnitine palmitoyltransferase II	CPT2	E
Carnitine transporter protein	CDSP, SCD	T
Carnosinase		N
Cartilage-hair hypoplasia gene	CHH	N
Catechol-O-methyltransferase	COMT	E
Cell adhesion molecule, intercellular, ICAM	ICAM1	G
Cell adhesion molecule, leukocyte-endothelial, LECAM (CD62)	LECAM1	G
Cell adhesion molecule, liver, LCAM	LCAM	G
Cell adhesion molecule, neural, NCAM1	NCAM1	G
Cell adhesion molecule, neural, NCAM120	NCAM120	G
Cell adhesion molecule, neural, NCAM2	NCAM2	G
Cell adhesion molecule, platelet-endothelial, PECAM	PECAM1	G
Cell adhesion molecule, vascular, VCAM	VCAM1	G
c-erbB2	ERBB2	G
c-erbB3	ERBB3	G
c-erbB4	ERBB4	G
Chitotriosidase	chit	E
Cholecystokinin	CCK	N
Cholecystokinin B receptor	CCKBR	N
Cholesterol ester hydroxylase		E



Cholesterol ester transfer protein	CETP	T
Choline acetyltransferase	CHAT	E
Chromogranin A	CHGA	G
Chymase	CHY1	
Citrate synthase		E
Clathrin		T
Clusterin	CLU	G
CoA transferase		E
Collagen IV alpha 5	COL4A5	S
Collagen IV alpha 6	COL4A6	S
Complex III		E
Complex V	MTATP6	E
Corticosteroid binding globulin	CBG	N
Corticotrophin-releasing hormone	CRH	T
Corticotrophin-releasing hormone receptor	CRHR1	T
Cortisol receptor		I
Cubilin	CUBN	T
Cyclic AMP-dependent protein kinase	PKA	E
Cyclic nucleotide phosphodiesterase 1B	PDE1B	E
Cyclic nucleotide phosphodiesterase 1B1	PDE1B1	E
Cyclic nucleotide phosphodiesterase 2A3	PDE2A3	E
Cyclic nucleotide phosphodiesterase 3A	PDE3A	E
Cyclic nucleotide phosphodiesterase 3B	PDE3B	E
Cyclic nucleotide phosphodiesterase 4A	PDE4A	E
Cyclic nucleotide phosphodiesterase 4C	PDE4C	E
Cyclic nucleotide phosphodiesterase 5A	PDE5A	E
Cyclic nucleotide phosphodiesterase 6A	PDE6A	E
Cyclic nucleotide phosphodiesterase 6B	PDE6B	E
Cyclic nucleotide phosphodiesterase 7	PDE7	E
Cyclic nucleotide phosphodiesterase 8	PDE8	E
Cyclic nucleotide phosphodiesterase 9A	PDE9A	E
Cyclin-dependent kinase inhibitor 1C (P57, KIP2)	CDKN1C	G
Cyclin-dependent kinase inhibitor 2A (p16)	CDKN2A	G
Cyclooxygenase 1	COX1	E
Cyclooxygenase 2	COX2	E
CYP11A1	CYP11A1	E
CYP11B1	CYP11B1	E
CYP11B2	CYP11B2	E
CYP17	CYP17	E
CYP19	CYP19	E
CYP1A1	CYP1A1	E
CYP1A2	CYP1A2	E
CYP1B1	CYP1B1	E
CYP21	CYP21	E
CYP24	CYP24	E
CYP27	CYP27	E
CYP27B1	PDDR	E

CYP2A1	CYP2A1	E
CYP2A13	CYP2A13	E
CYP2A3	CYP2A3	E
CYP2A6V2	CYP2A6V2	E
CYP2A7	CYP2A7	E
CYP2B6	CYP2B6	E
CYP2C18	CYP2C18	E
CYP2C19	CYP2C19	E
CYP2C8	CYP2C8	E
CYP2C9	CYP2C9	E
CYP2D6	CYP2D6	E
CYP2E1	CYP2E1	E
CYP2F1	CYP2F1	E
CYP2J2	CYP2J2	E
CYP3A3	CYP3A3	E
CYP3A4	CYP3A4	E
CYP3A5	CYP3A5	E
CYP3A7	CYP3A7	E
CYP4A11	CYP4A11	E
CYP4B1	CYP4B1	E
CYP4F2	CYP4F2	E
CYP4F3	CYP4F3	E
CYP51	CYP51	E
CYP5A1	CYP5A1	E
CYP7A	CYP7A	E
CYP8	CYP8	E
Cystathionase	CTH	E
Cystathione beta synthase	CBS	E
Cystic fibrosis transmembrane conductance regulator, CFTR	CFTR	N
Cystinosin	CTNS	T
Cytidine deaminase	CDA	E
Cytidine-5-prime-triphosphate synthetase	CTPS	E
Cytochrome a		E
Cytochrome c		E
Cytochrome c oxidase, MTCO		E
Cytokine-suppressive antiinflammatory drug- binding protein 1	CSBP1	I
Cytokine-suppressive antiinflammatory drug- binding protein 2	CSBP2	I
DAX1 nuclear receptor	DAX1	I
D-beta-hydroxybutyrate dehydrogenase		E
Dehydratase		E
Delta 4-5 oxosteroid isomerase		E
Delta aminolevulinate synthase 1	ALAS1	E
Delta aminolevulinate synthase 2	ALAS2	E
Deoxycorticosterone (DOC) receptor		E
Deoxyuridine triphosphatase; dUTPase		E

DHEA sulfotransferase	STD	E
Dihydrodiol dehydrogenase 1	DDH1	E
Dihydrolipoamide branched chain transacylase	DBT	N
Dihydrolipoamide dehydrogenase	DLD	N
Dihydrolipoyl dehydrogenase 2	PDHA	E
Dihydrolipoyl transacetylase	PDHA	E
Dihydroorotase		E
Dihydropyrimidinase	DPYS	E
Dihydroxyacetonephosphate acyltransferase	DHAPAT	E
Dihydropyrimidine dehydrogenase	DPYD	E
DNA glycosylases		E
DNA helicases		E
DNA Ligase 1	LIG1	E
DNA methyltransferase	DNMT	E
DOPA decarboxylase	DDC	E
Dopamine beta hydroxylase	DBH	E
Dopamine receptors D1	DRD1	N
Dopamine receptors D2	DRD2	N
Dopamine receptors D3	DRD3	N
Dopamine receptors D4	DRD4	N
Dopamine receptors D5	DRD5	N
Dynamin	DNM1	G
Electron-transferring-flavoprotein alpha	ETFA	T
Electron-transferring-flavoprotein beta	ETFB	T
Electron-transferring flavoprotein dehydrogenase	ETFDH	E
Endometrial bleeding-associated factor	EBAF	G
Endothelin converting enzyme	ECE1	N
Endothelin receptor type A	EDNRA	N
Endothelin receptor type B	EDNRB	N
Enolase	ENO1	E
Enoyl CoA reductase		E
Enterokinase	PRSS7, ENTK	E
Ephrin receptor tyrosine kinase A	EPHA	G
Ephrin receptor tyrosine kinase B	EPHB	G
Epidermal growth factor	EGF	G
Epidermal growth factor receptor	EGFR	G
Erythropoietin	EPO	I
Estrogen receptor	ESR	G
Excision repair complementation group 1 protein	ERCC1	E
Factor 1 (No. one)	F1	I
FADH dehydrogenase		E
Fatty acid binding proteins FABP2	FABP2	T
Fc fragment of IgG, high affinity IA, receptor for	FCGR1A	G
Fc fragment of IgG, low affinity IIa, receptor	FCGR2A	G

for (CD32)		
Fc fragment of IgG, low affinity IIIa, receptor	FCGR3A	G
for (CD16)		
Ferritin, H subunit		T
Ferritin, L subunit	FTL	T
Fibrinogen alpha	FGA	S
Fibrinogen beta	FGB	S
Fibrinogen gamma	FGG	S
Fibroblast growth factor	FGF1	G
Fibroblast growth factor receptor 1	FGFR1	G
Fibroblast growth factor receptor 2	FGFR2	G
Fibroblast growth factor receptor 3	FGFR3	G
Flavin-containing monooxygenase 1	FMO1	E
Flavin-containing monooxygenase 2	FMO2	E
Flavin-containing monooxygenase 3	FMO3	E
Flavin-containing monooxygenase 4	FMO4	E
Follicle stimulating hormone receptor	FSHR, ODG1	G
Follicle stimulating hormone, FSH	FSHB	G
Follistatin		G
Frataxin	FRDA	G
Fructose-1,6-diphosphatase	FBP1	E
Fumarase	FH	E
Fumarylacetoacetase	FAH	E
GABA receptor, alpha 1	GABRA1	N
GABA receptor, alpha 2	GABRA2	N
GABA receptor, alpha 3	GABRA3	N
GABA receptor, alpha 4	GABRA4	N
GABA receptor, alpha 5	GABRA5	N
GABA receptor, alpha 6	GABRA6	N
GABA receptor, beta 1	GABRB1	N
GABA receptor, beta 2	GABRB2	N
GABA receptor, beta 3	GABRB3	N
GABA receptor, gamma 1	GABRG1	N
GABA receptor, gamma 2	GABRG2	N
GABA receptor, gamma 3	GABRG3	N
GABA transaminase	ABAT	E
Galactocerebrosidase	GALC	E
Galactokinase	GALK1	E
Galactose 1-phosphate uridyl-transferase	GALT	E
Galanin	GAL	N
Galanin receptor	GALNR1	N
Gamma-glutamyl carboxylase	GGCX	T
Gamma-glutamyltransferase 1	GGT1	T
Gamma-glutamyltransferase 2	GGT2	T
Gap junction protein beta 1	GJB1	T
Gap junction protein beta 3	GJB3	T
Gastric inhibitory polypeptide GIP	GIP	T
Gastric inhibitory polypeptide receptor, GIPR	GIPR	T

Gastric Intrinsic factor, GIF	GIF	E
Gastric lipase, LIPF		T
Gastrin	GAS	G
Gastrin releasing peptide	GRP	T
Gastrin releasing peptide receptor	GRPR	T
Glucagon receptor	GCGR	G
Glucagon synthase		T
Glucagon-like peptide receptor 1	GLP1R	G
Glucocorticoid receptor	GRL	G
Glucokinase	GCK	E
Glucosaminyl (N-acetyl) transferase 2, I- branching enzyme	GCNT2	E
Glucose-6-phosphatase	G6PC	E
Glucose-6-phosphatase translocase	G6PT1	E
Glucose-6-phosphate dehydrogenase	G6PD	E
Glucosidase, acid beta	GBA	E
Glutamate decarboxylase, GAD	GAD1	E
Glutamate dehydrogenase	GLUD1	E
Glutamine phosphoribosylpyrophosphate amidotransferase/PRPP amidotransferase		E
Glutamine synthase		E
Glutathione	GSH	T
Glutathione peroxidase, GPX2	GPX2	E
Glutathione reductase, GSR	GSR	E
Glutathione S-transferase, GSTZ1	GSTZ1	E
Glutathione synthetase	GSS	E
Glyceraldehyde-3-phosphate dehydrogenase, GAPDH		E
GAPDH		
Glycerol kinase	GK	E
Glycerophosphate dehydrogenase 2	GPD2	E
Glycinamide ribonucleotide (GAR) transformylase	GART	E
Glycine dehydrogenase	GLDC	E
Glycogen branching enzyme	GBE1	E
Glycogen phosphorylase	PYGL	E
Glycogen synthase 1 (muscle)	GLYS1	E
Glycogen synthase 2 (liver)	GYS2	E
Glycosyltransferases, ABO blood group	ABO	E
Gonadotropin releasing hormone	GNRH	G
Gonadotropin releasing hormone receptor	GNRHR	G
Growth arrest-specific homeobox	GAX	G
Growth hormone 1	GH1	G
Growth hormone 2 (placental)	GH2	G
Growth hormone receptor	GHR	G
Growth hormone releasing hormone (GHRH)	GHRH	G
Growth hormone releasing hormone receptor	GHRHR	G
GTP cyclohydrolase 1	GCH1	G
GTPase-activating protein, GAP	RASA1	G

Guanidinoacetate N-methyltransferase	GAMT	E
Guanine nucleotide-binding protein, alpha activating activity polypeptide, GNAO	GNAO1	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 1, GNAI1	GNAI1	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 2, GNAI2	GNAI2	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 3, GNAI3	GNAI3	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS1	GNAS1	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS2	GNAS2	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS3	GNAS3	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS4	GNAS4	N
Guanine nucleotide-binding protein, alpha transducing activity polypeptide, GNAT1	GNAT1	N
Guanine nucleotide-binding protein, alpha transducing activity polypeptide, GNAT2	GNAT2	N
Guanine nucleotide-binding protein, beta polypeptide 3	GNB3	N
Guanine nucleotide-binding protein, gamma polypeptide 5	GNG5	N
Guanine nucleotide-binding protein, q polypeptide	GNAQ	N
Guanylate cyclase 2D, membrane (retina-specific)	GUCY2D	E
Guanylate cyclase activator 1A (retina)	GUCA1A	E
Guanylate kinase		E
Guanylin	GUCA2	T
Guanylyl cyclase		E
Heat shock protein, HSP60		I
Heat shock protein, HSP70		I
Heat shock protein, HSP90		I
Heat shock protein, HSPA1		I
Heat shock protein, HSPA2		I
Hemopexin	HPX	I
Heparin binding epidermal growth factor	HBEGF	G
Hepatic lipase	LIPC	E
Hepatic nuclear factor-3-beta	HNF3B	E
Hepatic nuclear factor-4-alpha	HNF4A	E
Hexokinase 1	HK1	E
Hexokinase 2	HK2	E
Hexosaminidase A	HEXA,TSD	E
Hexosaminidase B	HEXB	E
Histamine receptors, H1		N

Histamine receptors, H2		N
Histamine receptors, H3		N
HMG-CoA lyase	HMGCL	E
HMG-CoA reductase	HMGCR	E
HMG-CoA synthase	HMGCS2	E
Holocarboxylase synthetase	HLCS	E
Holoprosencephaly 1	HPE1	G
Holoprosencephaly 2	HPE2	G
Holoprosencephaly 3	HPE3	G
Holoprosencephaly 4	HPE4	G
Homeobox (HOX) gene A13	HOXA13	G
Hormone-sensitive lipase	HSL	E
HSSB, replication protein		E
Human chorionic gonadotrophin, hCG	CG	G
Human placental lactogen	CSH1	G
Hydroxyacyl glutathione hydrolase	HAGH	E
Hypoxanthine-guanine phosphoribosyltransferase, HGPRT	HPRT	E
Hypoxia inducible factor 1	HIF1A	E
Hypoxia inducible factor 2		E
Iduronate 2 sulphatase	IDS	E
Immunoglobulin E (IgE) responsiveness gene	IGER	I
Immunoglobulin E (IgE) serum concentration regulator gene	IGES	I
Immunoglobulin gamma (IgG) 2	IGHG2	I
Indian hedgehog, ihh	IHH	G
Inhibin, alpha	INHA	G
Inhibin, beta A	INHBA	G
Inhibin, beta B	INHBB	G
Inhibin, beta C	INHBC	G
Inosine monophosphate dehydrogenase, IMPDH		E
Inosine triphosphatase	ITPA	E
Inositol 1,4,5-triphosphate receptor 1	ITPR1	G
Inositol monophosphatase	IMPA1	N
Inositol polyphosphate 1-phosphatase	INPP1	N
Insulin	INS	G
Insulin receptor	INSR	G
Insulin receptor substrate-1	IRS1	G
Insulin-like growth factor 1	IGF1	G
Insulin-like growth factor 1 receptor	IGF1R	G
Insulin-like growth factor 2	IGF2	G
Insulin-like growth factor 2 receptor	IGF2R	G
Integrin beta 1	ITGB1	G
Integrin beta 2	ITGB2	G
Interleukin(IL) 1 receptor	IL1R	I
Interleukin(IL) 1, alpha	IL1A	I
Interleukin(IL) 1, beta	IL1B	I

Interleukin(IL) 10	IL10	I
Interleukin(IL) 10 receptor	IL10R	I
Interleukin(IL) 11	IL11	I
Interleukin(IL) 11 receptor	IL11R	I
Interleukin(IL) 12	IL12	I
Interleukin(IL) 12 receptor, beta 1	IL12RB1	I
Interleukin(IL) 13	IL13	I
Interleukin(IL) 13 receptor	IL13R	I
Interleukin(IL) 2	IL2	I
Interleukin(IL) 2 receptor, alpha	IL2RA	I
Interleukin(IL) 2 receptor, gamma	IL2RG	I
Interleukin(IL) 3	IL3	I
Interleukin(IL) 3 receptor	IL3R	I
Interleukin(IL) 4	IL4	I
Interleukin(IL) 4 receptor	IL4R	I
Interleukin(IL) 5	IL5	I
Interleukin(IL) 5 receptor	IL5R	I
Interleukin(IL) 6	IL6	I
Interleukin(IL) 6 receptor	IL6R	I
Interleukin(IL) 7	IL7	I
Interleukin(IL) 7 receptor	IL7R	I
Interleukin(IL) 8	IL8	I
Interleukin(IL) 8 receptor	IL8R	I
Interleukin(IL) 9	IL9	I
Interleukin(IL) 9 receptor	IL9R	I
Interleukin(IL) receptor antagonist 1	IL1RN, IL1RA	I
Iodothyronine-5'-deiodinase, type 1 and 2		E
IP3 kinase		E
Islet amyloid polypeptide	IAPP	N
Isocitrate dehydrogenase		E
Isovaleric acid CoA dehydrogenase	IVD	E
Janus kinase 1	JAK1	G
Janus kinase 2	JAK2	G
Janus kinase 3	JAK3	G
Kallman syndrome gene 1	KAL1	G
Ketohexokinase	KHK	E
ketolase		E
Lactase		E
Lactotransferrin	LTF	T
Laminin 5, alpha 3	LAMA3	G
Laminin 5, beta 3	LAMB3	G
Laminin receptor 1	LAMR1	G
Lecithin-cholesterol acyltransferase	LCAT	E
Leptin	LEP	G
Leptin receptor	LEPR	G
Leukotriene C4 synthase	LTC4S	E
LH/choriogonadotropin (CG) receptor	LHCGR	G
Lipoamide dehydrogenase	OGDH	E



Lipoprotein lipase	LPL	I
Lipoprotein, High Density	HDLDT1	T
Lipoprotein, Intermediate Density		T
Lipoprotein, Low Density 1		T
Lipoprotein, Low Density 2		T
Lipoprotein, Very Low Density	VLDLR	T
Lipoprotein-associated coagulation factor	LACI	I
Lipoxygenase		E
Lipoxygenase 12 (platelets)	LOG12	I
Lipoxygenase 5 (leukocytes)		I
Luteinizing hormone, beta chain	LHB	G
Lymphocyte-specific protein tyrosine kinase	LCK	I
Lysosomal acid lipase	LIPA	E
MAD (mothers against decapentaplegic, Drosophila) homologue 2	MADH2	G
Malate dehydrogenase, mitochondrial	MDH2	E
Malonyl CoA decarboxylase		E
Malonyl CoA transferase		E
Maltase-glucoamylase		E
Mannosidase, alpha B lysosomal	MANB	E
Mannosyl (alpha-1,6-)-glycoprotein beta-1, 2-	MGAT2	T
N-acetylglucosaminyltransferase		
Marenostrin	MEFV	T
Matrix Gla protein	MGP	G
MEK kinase, MEKK		E
Melanocortin 2 receptor	MC2R	T
Melanocortin 4 receptor	MC4R	T
Menin	MEN1	G
Methionine adenosyltransferase	MAT1A, MAT2A	E
Methionine synthase	MTR	E
Methionine synthase reductase	MTRR	E
Methylguanine-DNA methyltransferase	MGMT	E
Methylmalonyl-CoA mutase	MUT	E
Mitochondrial trifunctional protein, alpha subunit	HADHA	E
Mitochondrial trifunctional protein, beta subunit	HADHB	E
Molybdenum cofactor synthesis 1	MOCS1	E
Molybdenum cofactor synthesis 2	MOCS2	E
Monoamine oxidase A	MAOA	E
Monoamine oxidase B	MAOB	E
Multidrug resistance associated protein	MRP	G
Muscarinic receptor, M1	CHRM1	N
Muscarinic receptor, M2	CHRM2	N
Muscarinic receptor, M3	CHRM3	N
Muscarinic receptor, M4	CHRM4	N
Muscarinic receptor, M5	CHRM5	N
Muscle phosphorylase	PYGM	E

Na <sup>+</sup> , K <sup>+</sup> ATPase, alpha	ATP1A1	G
Na <sup>+</sup> , K <sup>+</sup> ATPase, beta 1	ATP1B1	G
Na <sup>+</sup> , K <sup>+</sup> ATPase, beta 2	ATP1B2	G
Na <sup>+</sup> , K <sup>+</sup> ATPase, beta 3	ATP1B3	G
Na <sup>+</sup> /H <sup>+</sup> exchanger 1	NHE1	T
Na <sup>+</sup> /H <sup>+</sup> exchanger 2	NHE2	T
Na <sup>+</sup> /H <sup>+</sup> exchanger 3	NHE3	T
Na <sup>+</sup> /H <sup>+</sup> exchanger 4	NHE4	T
Na <sup>+</sup> /H <sup>+</sup> exchanger 5	NHE5	T
N-acetyltransferase 1	NAT1	E
N-acetyltransferase 2	NAT2	E
NADH dehydrogenase (ubiquinone) Fe-S protein 1	NDUFS1	E
NADH dehydrogenase (ubiquinone) Fe-S protein 4	NDUFS4	E
NADH dehydrogenase (ubiquinone) flavoprotein 1	NDUFV1	E
NADH-cytochrome b5 reductase	DIA1	E
NADPH-dependent cytochrome P450 reductase	POR	E
Nephronophthisis 1	NPHP1	T
Nephrosis 1	NPHS1	T
Nerve growth factor	NGF	G
Nerve growth factor receptor	NGFR	G
Neuraminidase sialidase	NEU	T
Neuregulin	HGL	G
Neuroendocrine convertase 1	NEC1, PCSK1	E
Neurofibromin 1	NF1	G
Neurofibromin 2	NF2	G
Neuropeptide Y	NPY	N
Neuropeptide Y receptor Y1	NPY1R	N
Neuropeptide Y receptor Y2	NPY2R	N
Neurotensin	NTS	N
Neurotensin receptor	NTSR1	N
Neurotrophin 3	NTF3 or NT3	G
Neutral endopeptidase		E
Niemann-Pick disease protein	NPC1	T
Nitric oxide synthase 1, NOS1	NOS1	E
Nitric oxide synthase 2, NOS2	NOS2	E
Nitric oxide synthase 3, NOS3	NOS3	E
Notch ligand - jagged 1	JAG1, AGS	G
Nucleoside diphosphate kinase-A	NDPKA	E
Oncogene ret	RET	G
Oncogene sis	PDGFB	G
Orexin	OX	G
Orexin 1 receptor	OX1R	G
Orexin 2 receptor	OX2R	G
Ornithine delta-aminotransferase	OAT	E

Ornithine transcarbamoylase	OTC, NME1	E
Oxytocin	OXT	N
Oxytocin receptor	OXTR	N
Paired box homeotic gene 6	PAX6	G
Paired box homeotic gene 8	PAX8	G
Palmitoyl-protein thioesterase	PPT	T
Pancreatic lipase	PNLIP	E
Paraoxonase PON1	PON1	E
Paraoxonase PON2	PON2	E
Paraoxonase PON3		E
Parathyroid hormone	PTH	G
Parathyroid hormone receptor	PTHr1	G
Parathyroid hormone related-peptide	PTHrP	G
Parathyroid hormone-like hormone	PTHLH	G
Peanut-like 1	PNUTL1	I
Peptidylglycine alpha-amidating monooxygenase	PAM	E
Peroxidase, salivary	SAPX	E
Peroxisomal membrane protein 3	PXMP3	T
Peroxisome biogenesis factor 1	PEX1	T
Peroxisome biogenesis factor 19	PEX19	T
Peroxisome biogenesis factor 6	PEX6	T
Peroxisome biogenesis factor 7	PEX7	T
Peroxisome proliferative activated receptor, alpha	PPARA	T
Peroxisome proliferative activated receptor, gamma	PPARG	T
P-glycoprotein 1	PGY1	T
P-glycoprotein 3	PGY3	T
Phenylalanine hydroxylase	PAH	E
Phenylalanine monooxygenase		E
Phenylethanolamine N-methyltransferase, PNMT	PNMT	E
Phosphodiesterase 1 / nucleotide pyrophosphatase 1	PDNP1	G
Phosphodiesterase 1 / nucleotide pyrophosphatase 2	PDNP2	G
Phosphodiesterase 1 / nucleotide pyrophosphatase 3	PDNP3	G
Phosphoenolpyruvate carboxykinase	PCK1	E
Phosphofructokinase, liver	PFKL	E
Phosphofructokinase, muscle	PFKM	E
Phosphoglucosmutase		E
Phosphoglucose isomerase	GPI	E
Phosphoglycerate kinase 1	PGK1	E
Phosphoglycerate mutase 2	PGAM2	E
Phospholipase A2, group 10	PLA2G10	I
Phospholipase A2, group 1B	PLA2G1B	I

Phospholipase A2, group 2A	PLA2G2A	I
Phospholipase A2, group 2B	PLA2G2B	I
Phospholipase A2, group 4A	PLA2G4A	I
Phospholipase A2, group 4C	PLA2G4C	I
Phospholipase A2, group 5	PLA2G5	I
Phospholipase A2, group 6	PLA2G6	I
Phospholipase C alpha		I
Phospholipase C beta		I
Phospholipase C delta	PLCD1	I
Phospholipase C epsilon		I
Phospholipase C gamma	PLCG1	I
Phosphomannomutase 2	PMM2	G
Phosphomannomutase-2	PMM2	T
Phosphomannose isomerase-1, PMI1	MPI	T
Phosphoribosyl pyrophosphate synthetase	PRPS1	E
Phosphorylase kinase deficiency, liver	PHK	E
Phosphorylase kinase, alpha 1 (muscle)	PHKA1	E
Phosphorylase kinase, alpha 2	PHKA2	E
Phosphorylase kinase, beta	PHKB	E
Phosphorylase kinase, delta		E
Phosphorylase kinase, gamma 2	PHKG2	E
Phytanoyl-CoA hydroxylase	PHYH	G
Pineolytic beta-receptors		E
Pituitary adenylate cyclase activating peptide	PACAP	N
Pituitary adenylate cyclase activating peptide receptor	PACAP1R	N
Plasminogen activator receptor, Urokinase	UPAR; PLAUR	S
Plasminogen activator, Tissue	PLAT; TPA	E
Plasminogen activator, Urokinase	UPA; PLAU	E
Platelet derived growth factor	PDGF	G
Platelet derived growth factor receptor	PDGFR	G
Poly (ADP-ribose) synthetase	PARS	E
Polycystin 1	PKD1	T
Polycystin 2	PKD2	T
Porphobilinogen deaminase	HMBS	E
Potassium inwardly-rectifying channel J1	KCNJ1	N
Potassium inwardly-rectifying channel J11	KCNJ11	N
Potassium voltage-gated channel A1	KCNA1	N
Potassium voltage-gated channel E1	KCNE1	N
Potassium voltage-gated channel Q1	KCNQ1	N
Preproenkephalin	PENK	N
Preproglucagon	GCG;GLP1; GLP2	G
Preproglucagon		T
Preproinsulin		T
Profibrinolysin		G
Progesterone receptor (RU486 binding receptor)	PGR	G
Prolactin	PRL	G

Prolactin receptor	PRLR	G
Prolactin releasing hormone	PRH	G
Proliferin	PLF	G
Proline dehydrogenase	PRODH	E
Proline-rich protein BstNI subfamily 1	PRB1	S
Proline-rich protein BstNI subfamily 3	PRB3	S
Proline-rich protein BstNI subfamily 4	PRB4	S
Pro-melanin-concentrating hormone	PMCH	G
Proopiomelanocortin	POMC	N
Prophet of Pit1	PROP1	G
Prostacyclin synthase		I
Prostaglandin (PG) D synthase, hematopoietic	PGDS	E
Prostaglandin 15-OH dehydrogenase	HGPD; PGDH	I
Prostaglandin D - DP receptor		I
Prostaglandin E1 receptor		I
Prostaglandin E2 receptor		I
Prostaglandin E3 receptor		I
Prostaglandin F - FP receptor		I
Prostaglandin I2 receptor		T
Prostaglandin IP receptor		I
Prostaglandin isomerase		G
Prostasin, PRSS8	PRSS8	E
Protease nexin 2	PN2	E
Protein kinase B	PRKB	
Protein kinase C, alpha	PRKCA	E
Protein S	PROS1	I
Protoporphyrinogen oxidase	PPOX	E
Pterin-4-alpha-carbinolamine	PCBD	
Pyrroline-5-carboxylate synthetase	PYCS	E
Pyruvate carboxylase	PC	E
Pyruvate decarboxylase	PDHA	E
Pyruvate kinase	PKLR	E
Quinoid dihydropteridine reductase	QDPR	E
Rathke pouch homeobox, RPX	RPX	G
Relaxin H1	RLN1	G
Relaxin H2	RLN2	G
Renin	REN	E
Replication factor C	RFC2	E
Retinal pigment epithelium specific protein (65kD)	RPE65	S
Retinaldehyde binding protein 1	RLBP1	T
Retinoic acid receptor, alpha	RARA	G
Retinoic acid receptor, beta	RARB	G
Retinoic acid receptor, gamma	RARG	G
Retinoid X receptor, alpha	RXRA	G
Retinoid X receptor, beta	RXRB	G
Retinoid X receptor, gamma	RXRG	G

Retinol binding protein 1		T
Retinol binding protein 2		T
Ribosephosphate pyrophosphokinase		E
RIGUI	RIGUI	G
Ryanodine receptor 1, skeletal	RYR1	G
S100 calcium-binding protein A1	S100A1	N
S100 calcium-binding protein A2	S100A2	N
S100 calcium-binding protein A3	S100A3	N
S100 calcium-binding protein A4	S100A4	N
S100 calcium-binding protein A5	S100A5	N
S100 calcium-binding protein A6	S100A6	N
S100 calcium-binding protein A7	S100A7	N
S100 calcium-binding protein A8	S100A8	N
S100 calcium-binding protein A9	S100A9	N
S100 calcium-binding protein B	S100B	N
S100 calcium-binding protein P	S100P	N
S-adenosylmethionine decarboxylase, AMD		E
Salivary amylase, AMY1		T
Secretin	SCT	T
Secretin receptor, SCTR	SCTR	T
Serine hydroxymethyltransferase	SHMT	E
Serotonin N-acetyltransferase	SNAT	E
Serotonin receptor, 5HT1A	HTR1A	N
Serotonin receptor, 5HT1B	HTR1B	N
Serotonin receptor, 5HT1C	HTR1C	N
Serotonin receptor, 5HT1D	HTR1D	N
Serotonin receptor, 5HT1E	HTR1E	N
Serotonin receptor, 5HT1F	HTR1F	N
Serotonin receptor, 5HT2A	HTR2A	N
Serotonin receptor, 5HT2B	HTR2B	N
Serotonin receptor, 5HT2C	HTR2C	N
Serotonin receptor, 5HT3	HTR3	N
Serotonin receptor, 5HT4	HTR4	N
Serotonin receptor, 5HT5	HTR5	N
Serotonin receptor, 5HT6	HTR6	N
Serotonin receptor, 5HT7	HTR7	N
Serum amyloid A	SAA	T
Serum amyloid P	SAP	T
Sex determining region Y, SRY	SRY	G
Sex hormone binding globulin, SHBG		T
Sodium channel, non-voltage gated 1, alpha	SCNN1A	N
Sodium channel, non-voltage gated 1, beta	SCNN1B	N
Sodium channel, non-voltage gated 1, gamma	SCNN1G	N
Sodium channel, voltage-gated, type 1, beta polypeptide	SCN1B	N
Solute carrier family 1 (amino acid transporter), member 6	SLC1A6	T

Solute carrier family 1 (neutral amino acid transporter), member 4	SLC1A4	T
Solute carrier family 10 (sodium/bile acid cotransporter family), member 1	SLC10A1	T
Solute carrier family 10 (sodium/bile acid cotransporter family), member 2	SLC10A2	T
Solute carrier family 12, member 1	SLC12A1	T
Solute carrier family 12, member 2	SLC12A2	T
Solute carrier family 12, member 3	SLC12A3	T
Solute carrier family 14, member 2	SLC14A2	T
Solute carrier family 15 (H <sup>+</sup> /peptide transporter, intestinal), member 1	SLC15A1	T
Solute carrier family 15 (H <sup>+</sup> /peptide transporter, kidney), member 2	SLC15A2	T
Solute carrier family 16 (monocarboxylate transporter), member 1	SLC16A1	T
Solute carrier family 16 (monocarboxylate transporter), member 7	SLC16A7	T
Solute carrier family 17, member 1	SLC17A1	T
Solute carrier family 17, member 2	SLC17A2	T
Solute carrier family 2 (facilitated glucose transporter), member 1	SLC2A1	T
Solute carrier family 2 (facilitated glucose transporter), member 2	SLC2A2	T
Solute carrier family 2 (facilitated glucose transporter), member 3	SLC2A3	T
Solute carrier family 2 (facilitated glucose transporter), member 4	SLC2A4	T
Solute carrier family 2 (facilitated glucose transporter), member 5	SLC2A5	T
Solute carrier family 20, member 3	SLC20A3	T
Solute carrier family 21, member 2	SLC21A2	T
Solute carrier family 21, member 3	SLC21A3	T
Solute carrier family 22, member 1	SLC22A1	T
Solute carrier family 22, member 2	SLC22A2	T
Solute carrier family 22, member 5	SLC22A5	T
Solute carrier family 3 (facilitated glucose transporter), member 1	SLC3A1	T
Solute carrier family 4 (anion exchanger), member 1	SLC4A1	T
Solute carrier family 4 (anion exchanger), member 2	SLC4A2	T
Solute carrier family 4 (anion exchanger), member 3	SLC4A3	T
Solute carrier family 5 (sodium/glucose transporter), member 1	SLC5A1	T
Solute carrier family 5 (sodium/glucose transporter), member 2	SLC5A2	T

Solute carrier family 5 (sodium/glucose transporter), member 5	SLC5A5	T
Solute carrier family 5, member 3	SLC5A3	T
Solute carrier family 6 (GAMMA-AMINO BUTYRIC ACID transporter), member 1	SLC6A1	T
Solute carrier family 6 (neurotransmitter transporter, dopamine), member 3	SLC6A3	T
Solute carrier family 6 (neurotransmitter transporter, noradrenaline), member 2	SLC6A2	T
Solute carrier family 6 (neurotransmitter transporter, serotonin), member 4	SLC6A4	T
Solute carrier family 6, member 10	SLC6A10	T
Solute carrier family 6, member 6	SLC6A6	T
Solute carrier family 6, member 8	SLC6A8	T
Solute carrier family 7 (amino acid transporter), member 1	SLC7A1	T
Solute carrier family 7 (amino acid transporter), member 2	SLC7A2	T
Solute carrier family 7 (amino acid transporter), member 7	SLC7A7	T
Solute carrier family 8 (sodium/calcium exchanger), member 1	SLC8A1	T
Somatostatin	SST	N
Somatostatin receptor, SSTR1	SSTR1	N
Somatostatin receptor, SSTR2	SSTR2	G
Somatostatin receptor, SSTR3	SSTR3	N
Somatostatin receptor, SSTR4	SSTR4	N
Somatostatin receptor, SSTR5	SSTR5	N
Somatotrophin		G
Sorcin	SRI	T
SOS1 guanine nucleotide exchange factor	SOS1	G
Sperm protamine P1	PRM1	G
Sperm protamine P2	PRM2	G
Sphingomyelinase	SMPD1	E
SRY-box 10	SOX10	G
SRY-box 11	SOX11	G
SRY-box 3	SOX3	G
SRY-box 4	SOX4	G
SRY-box 9	SOX9	G
Steroid sulphatase	STS	E
Steroidogenic acute regulatory protein	STAR	T
Substance P		N
Succinyl CoA synthase		E
Sucrase		E
Sulfonylurea receptor	SUR	G
Superoxide dismutase 1	SOD1	E
Superoxide dismutase 3	SOD3	E



Surfeit 1	SURF1	G
T-BOX 1	TBX1	G
T-BOX 3	TBX3	G
Thiolase, peroxisomal		E
Thiopurine S-methyltransferase	TPMT	E
Thrombospondin	THBS1	G
Thromboxane A synthase 1	TBXAS1	I
Thromboxane A2	TXA2	I
Thromboxane A2 receptor	TBXA2R	I
Thymopoietin	TMPO	G
Thymosin		I
Thyroglobulin	TG	G
Thyroid hormone receptor, alpha	THRA	G
Thyroid hormone receptor, beta	THRB	G
Thyroid peroxidase	TPO	G
Thyroid receptor auxiliary protein	TRAP	G
Thyroid-stimulating hormone receptor	TSHR	G
Thyroid-stimulating hormone, alpha	TSHA	G
Thyroid-stimulating hormone, beta	TSHB	G
Thyrotropin releasing hormone	TRH	G
Thyrotropin releasing hormone receptor	TRHR	G
Thyroxin-binding globulin	TBG	T
Transacylase		E
Transcobalamin 2, TCN2	TCN2	T
Transcription factor 1, hepatic	TCF1	G
Transcription factor 2, hepatic	TCF2	G
Transcription termination factor, RNA polymerase 1	TTF1	G
Transferrin	TF	G
Transferrin receptor	TFRC	G
Transforming growth factor, beta 2	TGFB2	G
Transforming growth factor, beta induced	TGFB1	G
Transforming growth factor, beta receptor 2	TGFB2R	G
Transketolase	TKT	E
Transketolase-like 1	TKTL1	E
Transthyretin	TTR	T
Tubby-like protein 1	TULP1	G
Tuberous sclerosis 1	TSC1	G
Tuberous sclerosis 2	TSC2	G
Tyrosinase	TYR	E
Tyrosinase-related protein 1	TYRP1	E
Tyrosine aminotransferase	TAT	E
Tyrosine hydroxylase	TH	E
Ubiquitin activating enzyme, E1		E
Ubiquitin protein ligase E3A	UBE3A	E
UDP-glucose pyrophosphorylase		E
UDP-glucuronosyltransferase 1	ugt1d, UGT1	E
UDP-glucuronosyltransferase 2	UGT2	E

Uncoupling protein 1		T
Uncoupling protein 3	UCP3	T
Urate oxidase	UOX	E
Ureidopropionase		E
Uridine monophosphate kinase	UMPK	I
Uridine monophosphate synthetase	UMPS	I
Uridinediphosphate(UDP)-galactose-4-epimerase	GALE	E
Uroporphyrinogen decarboxylase	UROD	E
Uteroglobin	UGB	T
Vasoactive intestinal polypeptide	VIP	N
Vasoactive intestinal polypeptide receptor	VIPR	N
Vasoinhibitory peptide		G
Von Hippel-Lindau gene	VHL	G
Werner syndrome helicase	WRN	G
Wolfram syndrome 1 gene	WFS1	S
Xylitol dehydrogenase		E

In a fifteenth aspect.

## HEADACHE

The present invention relates to a method of assessing the risk of developing the symptoms of a headache, the causes of which are numerous – including; migraine, trauma, infection, psychiatric conditions and the use of drugs and toxins or as adverse events following the use of drugs (Walton, 1993, Lishman, 1997, Brody, Larner and Minneman 1998).

By far the most common causes of headache and other neurology are various forms of psychogenic and tension headaches and migraine (Lishman, 1997, Ferrari, 1998). Even in neurological clinics less than 5% of headaches are due to serious intracranial structural disease and most of these have additional and obvious neurological features.

It is difficult to assess the prevalence of headache sufferers as many patients will not consult a physician. An estimation of the prevalence of migraine indicates it is remarkably high across western countries, with about 20% of the population suffering at some time in their lives. 5% of the population have at least 18 migraine days per year and 1% at least one day per week. The annual cost of migraine-related lost productivity is enormous.

Classical migraine typically involves visual symptoms such as 'dazzles' or 'blind patches' spreading across the vision of one or both eyes. The headache normally starts as the neurological symptoms resolve. It is often severe lasting hours or rarely days, and may be accompanied by nausea or vomiting. Photophobia, facial pallor, intolerance to certain odours, irritability, mild confusion and anorexia are common. Symptoms of an attack vary enormously but whatever combination of symptoms an individual has an migraine episode is obviously very distressing and debilitating to the sufferer (Ferrari, 1998).

Headaches can be an unwanted side effect of therapeutic drugs, e.g. following treatment with phosphodiesterase 5 inhibitors (Viagra<sup>TM</sup>), tri-cyclic antidepressants, indomethacin and nifedipine.

Treatment for headaches are primarily in the form of oral treatments but the particular drug used varies widely according to the cause of the headache. Treatment of a tension headache may also include stress avoidance or relaxation programmes together with mild analgesics or mild tranquilizers (e.g. diazepam). Acute antimigraine drugs include the ergot alkaloids (ergotamine and dihydroergotamine), sumatriptan, and other 'second generation' triptans (Ferrari, 1998, Brody, Larner and Minneman, 1998).

We have elaborated on the value and utility to be derived from the gathering together of the genes which form the core gene list for this particular Genostic system.

These genes are elaborated below:

**KEY TO 'PROTEIN FUNCTION' COLUMN**

E ENZYME  
 T TRANSPORT & STORAGE  
 S STRUCTURAL  
 I IMMUNITY  
 N NERVOUS TRANSMISSION  
 G GROWTH & DIFFERENTIATION

HEADACHE GENE LIST	HUGO symbol	Protein function
Acetylcholinesterase	ACHE	E
Adenylate cyclase 1	ADCY1	E
Adenylate cyclase 2	ADCY2	E
Adenylate cyclase 3	ADCY3	E
Adenylate cyclase 4	ADCY4	E
Adenylate cyclase 5	ADCY5	E
Adenylate cyclase 6	ADCY6	E
Adenylate cyclase 7	ADCY7	E
Adenylate cyclase 8	ADCY8	E
Adenylate cyclase 9	ADCY9	E
Adrenergic receptor, alpha1	ADRA1	N
Adrenergic receptor, alpha2	ADRA2	N
Adrenergic receptor, beta1	ADRB1	N
Adrenergic receptor, beta2	ADRB2	N
Adrenergic receptor, beta3	ADRB3	N
Angiopoietin 1	ANGPT1	G
Angiopoietin 2	ANGPT2	G
Angiotensin converting enzyme	ACE, DCP1	E
Angiotensin receptor 1	AGTR1	T
Angiotensin receptor 2	AGTR2	T
Angiotensinogen	AGT	E
Arginase	ARG1	E
Arginine vasopressin	AVP	N
Atrial natriuretic peptide	ANP	G
Atrial natriuretic peptide receptor A	NPR1	G
Atrial natriuretic peptide receptor B	NPR2	G
Atrial natriuretic peptide receptor C	NPR3	G
Calcitonin/Calcitonin gene-related peptide	CALCA	N
alpha		
Calcium channel, voltage-dependent, alpha 1F subunit	CACNA1F	N
Calcium channel, voltage-dependent, Alpha-1B (CACNL1A5)	CACNA1B	N
Calcium channel, voltage-dependent, Alpha-1C	CACNA1C	N
Calcium channel, voltage-dependent, Alpha-1D	CACNA1D	N

Calcium channel, voltage-dependent, Alpha-1E (CACNL1A6)	CACNA1E	N
Calcium channel, voltage-dependent, Alpha-2/delta	CACNA2	N
Calcium channel, voltage-dependent, Beta 1	CACNB1	N
Calcium channel, voltage-dependent, Beta 3	CACNB3	N
Calcium channel, voltage-dependent, Neuronal, Gamma	CACNG2	N
Calcium channel, voltage-dependent, P/Q type, alpha 1A subunit	CACNA1A	N
Calcium channel, voltage-dependent, T-type		N
Calnexin	CANX	G
Cannabinoid receptor	CNR1	N
Carbonic anhydrase 3	CA3	E
Carbonic anhydrase 4	CA4	E
Carbonic anhydrase, alpha	CA1	E
Carbonic anhydrase, beta	CA2	E
Catechol-O-methyltransferase	COMT	E
Choline acetyltransferase	CHAT	E
Cyclic AMP-dependent protein kinase	PKA	E
Cyclic nucleotide phosphodiesterase 1B	PDE1B	E
Cyclic nucleotide phosphodiesterase 1B1	PDE1B1	E
Cyclic nucleotide phosphodiesterase 2A3	PDE2A3	E
Cyclic nucleotide phosphodiesterase 3A	PDE3A	E
Cyclic nucleotide phosphodiesterase 3B	PDE3B	E
Cyclic nucleotide phosphodiesterase 4A	PDE4A	E
Cyclic nucleotide phosphodiesterase 4C	PDE4C	E
Cyclic nucleotide phosphodiesterase 5A	PDE5A	E
Cyclic nucleotide phosphodiesterase 6A	PDE6A	E
Cyclic nucleotide phosphodiesterase 6B	PDE6B	E
Cyclic nucleotide phosphodiesterase 7	PDE7	E
Cyclic nucleotide phosphodiesterase 8	PDE8	E
Cyclic nucleotide phosphodiesterase 9A	PDE9A	E
Cyclooxygenase 1	COX1	E
Cyclooxygenase 2	COX2	E
CYP11A1	CYP11A1	E
CYP11B1	CYP11B1	E
CYP11B2	CYP11B2	E
CYP17	CYP17	E
CYP19	CYP19	E
CYP1A1	CYP1A1	E
CYP1A2	CYP1A2	E
CYP1B1	CYP1B1	E
CYP21	CYP21	E
CYP24	CYP24	E
CYP27	CYP27	E
CYP27B1	PDDR	E
CYP2A1	CYP2A1	E

CYP2A13	CYP2A13	E
CYP2A3	CYP2A3	E
CYP2A6V2	CYP2A6V2	E
CYP2A7	CYP2A7	E
CYP2B6	CYP2B6	E
CYP2C18	CYP2C18	E
CYP2C19	CYP2C19	E
CYP2C8	CYP2C8	E
CYP2C9	CYP2C9	E
CYP2D6	CYP2D6	E
CYP2E1	CYP2E1	E
CYP2F1	CYP2F1	E
CYP2J2	CYP2J2	E
CYP3A3	CYP3A3	E
CYP3A4	CYP3A4	E
CYP3A5	CYP3A5	E
CYP3A7	CYP3A7	E
CYP4A11	CYP4A11	E
CYP4B1	CYP4B1	E
CYP4F2	CYP4F2	E
CYP4F3	CYP4F3	E
CYP51	CYP51	E
CYP5A1	CYP5A1	E
CYP7A	CYP7A	E
CYP8	CYP8	E
Cystathionase	CTH	E
Cystathione beta synthase	CBS	E
Cytidine deaminase	CDA	E
Cytidine-5-prime-triphosphate synthetase	CTPS	E
Cytochrome a		E
Cytochrome c		E
Cytochrome c oxidase, MTCO		E
Cytokine-suppressive antiinflammatory drug-binding protein 1	CSBP1	I
Cytokine-suppressive antiinflammatory drug-binding protein 2	CSBP2	I
Dopamine beta hydroxylase	DBH	E
Dopamine receptors D1	DRD1	N
Dopamine receptors D2	DRD2	N
Dopamine receptors D3	DRD3	N
Dopamine receptors D4	DRD4	N
Dopamine receptors D5	DRD5	N
Dystonia 9	CSE	S
Endothelin 1	EDN1	N
Endothelin 2	EDN2	N
Endothelin 3	EDN3	N
Endothelin converting enzyme	ECE1	N
Endothelin receptor type A	EDNRA	N

Endothelin receptor type B	EDNRB	N
Enolase	ENO1	E
Epidermal growth factor	EGF	G
Epidermal growth factor receptor	EGFR	G
Erythropoietin receptor	EPOR	I
Glutathione	GSH	T
Glutathione S-transferase, GSTZ1	GSTZ1	E
Glyceraldehyde-3-phosphate dehydrogenase, GAPDH	GAPDH	E
Glycerol kinase	GK	E
Glycinamide ribonucleotide (GAR) transformylase	GART	E
Hexosaminidase B	HEXB	E
Histamine receptors, H1		N
Histamine receptors, H2		N
Histamine receptors, H3		N
Hypoxia inducible factor 1	HIF1A	E
Hypoxia inducible factor 2		E
Insulin	INS	G
Insulin receptor	INSR	G
Interleukin(IL) 1, alpha	IL1A	I
Interleukin(IL) 1, beta	IL1B	I
Interleukin(IL) receptor antagonist 1	IL1RN, IL1RA	I
IP3 kinase		E
Marenostrin	MEFV	T
Methylmalonyl-CoA mutase	MUT	E
Monoamine oxidase A	MAOA	E
Monoamine oxidase B	MAOB	E
Muscarinic receptor, M1	CHRM1	N
Muscarinic receptor, M2	CHRM2	N
Muscarinic receptor, M3	CHRM3	N
Muscarinic receptor, M4	CHRM4	N
Muscarinic receptor, M5	CHRM5	N
Myogenic factor 3	MYF3	G
Myogenic factor 4	MYF4	G
Myogenic factor 5	MYF5	G
NADH dehydrogenase		E
NADPH-dependent cytochrome P450 reductase	POR	E
Neurokinin A	NKNA	N
Neurokinin B	NKNB	N
Neuropeptide Y	NPY	N
Neuropeptide Y receptor Y1	NPY1R	N
Neuropeptide Y receptor Y2	NPY2R	N
Nitric oxide synthase 1, NOS1	NOS1	E
Nitric oxide synthase 2, NOS2	NOS2	E
Nitric oxide synthase 3, NOS3	NOS3	E
Phospholipase A2, group 10	PLA2G10	I

Phospholipase A2, group 1B	PLA2G1B	I
Phospholipase A2, group 2A	PLA2G2A	I
Phospholipase A2, group 2B	PLA2G2B	I
Phospholipase A2, group 4A	PLA2G4A	I
Phospholipase A2, group 4C	PLA2G4C	I
Phospholipase A2, group 5	PLA2G5	I
Phospholipase A2, group 6	PLA2G6	I
Phospholipase C alpha		I
Phospholipase C beta		I
Phospholipase C delta	PLCD1	I
Phospholipase C epsilon		I
Phospholipase C gamma	PLCG1	I
Potassium inwardly-rectifying channel J1	KCNJ1	N
Potassium voltage-gated channel E1	KCNE1	N
Potassium voltage-gated channel Q1	KCNQ1	N
Proopiomelanocortin	POMC	N
RIGUI	RIGUI	G
Serotonin receptor, 5HT1A	HTR1A	N
Serotonin receptor, 5HT1B	HTR1B	N
Serotonin receptor, 5HT1C	HTR1C	N
Serotonin receptor, 5HT1D	HTR1D	N
Serotonin receptor, 5HT1E	HTR1E	N
Serotonin receptor, 5HT1F	HTR1F	N
Serotonin receptor, 5HT2A	HTR2A	N
Serotonin receptor, 5HT2B	HTR2B	N
Serotonin receptor, 5HT2C	HTR2C	N
Serotonin receptor, 5HT3	HTR3	N
Serotonin receptor, 5HT4	HTR4	N
Serotonin receptor, 5HT5	HTR5	N
Serotonin receptor, 5HT6	HTR6	N
Serotonin receptor, 5HT7	HTR7	N
Sodium channel, non-voltage gated 1, alpha	SCNN1A	N
Sodium channel, non-voltage gated 1, beta	SCNN1B	N
Sodium channel, non-voltage gated 1, gamma	SCNN1G	N
Sodium channel, voltage-gated, type 1, beta	SCN1B	N
polypeptide		
Solute carrier family 5, member 3	SLC5A3	T
Solute carrier family 6 (GAMMA-AMINOBTYRIC ACID transporter), member 1	SLC6A1	T
Solute carrier family 6 (neurotransmitter transporter, dopamine), member 3	SLC6A3	T
Solute carrier family 6 (neurotransmitter transporter, noradrenaline), member 2	SLC6A2	T
Substance P		N
Tyrosine hydroxylase	TH	E
UDP-glucuronosyltransferase 1	ugt1d, UGT1	E
UDP-glucuronosyltransferase 2	UGT2	E
Vasoactive intestinal polypeptide	VIP	N



Vasoactive intestinal polypeptide receptor

VIPR

N

In a sixteenth aspect.

## SEXUAL DYSFUNCTION

The present invention relates to a method of assessing the risk of developing the symptoms of sexual dysfunction in women and men and impotence or erectile dysfunction in men. Sexual dysfunction is a common consequence of psychiatric or neuropsychiatric disorders or following traumatic brain injury, ischaemic brain damage or stroke or systemic diseases (such as cardiovascular disease) or following psychological or social stress.

Sexual dysfunction arises in a significant majority of cases as a result of a recognisable physical or physiological condition. Causes include, dysfunctional regulation of the vasculature, diabetes, peripheral neuropathy, peyronies disease, prostate disease and neurological lesions (such as those following spinal cord trauma. However, it is also of importance to note that sexual dysfunction is commonly observed as a consequence of individuals experiencing psychological or social stress following difficulties in their interpersonal relationships, work relationships or other concerns resulting from their social or economic circumstances.

Sexual dysfunction is also a common adverse event following standard therapeutic practices and is a known adverse event following treatments with anti-depressants, anti-convulsants, anti-psychotics, cholinomimetics, sympathomimetic and sympatholytics (Brody, Lerner and Minneman 1998).

The symptoms of sexual dysfunction are a cause of significant anxiety and stress in patients or persons suffering from them. The problem of sexual dysfunction is a large one with an estimated 20 million American males suffering from some aspect of sexual difficulties.

Such symptoms lead to difficulties in the clinical care of patients, difficulties in the treatment and recovery of patients and lead to stress and anxiety in their carers and families.

Treatment of sexual dysfunction has traditionally been via hormone replacement or supplementation, urethral suppositories, penile injections or implant surgery. Recently oral treatments such as phosphodiesterase 5 inhibitors have also become available (e.g. Viagra<sup>TM</sup> from Pfizer).

There is as yet no clear explanation as to why sexual dysfunction should affect some and not others or why some suffer from sexual dysfunction as a result of therapeutic intervention whereas others do not. The biology underpinning the appearance of sexual dysfunction is uncertain and its genetic background unknown (OMIM Database 1998).

The uncertainties surrounding sexual dysfunction have been heightened in recent months following the availability of oral treatments for the problem and the realisation that these treatments are not 100% effective in the whole population.

It is presumed that a similar (although perhaps less extreme) physiology underlies the expression of the symptoms of sexual dysfunction in persons who experience these difficulties without the background of a diagnosable disease or psychiatric condition.

Although little is known concerning the pathophysiology of sexual dysfunction it has been observed that there is considerable inter-personal variation in the likelihood, threshold and magnitude of sexual dysfunction even in persons suffering from the same clinical condition or experiencing the same social or economic conditions (Lishman 1997).

We have elaborated on the value and utility to be derived from the gathering together of the genes which form the core gene list for this particular Genostic system.

These genes are elaborated below:

#### KEY TO 'PROTEIN FUNCTION' COLUMN

E ENZYME  
T TRANSPORT & STORAGE  
S STRUCTURAL  
I IMMUNITY  
N NERVOUS TRANSMISSION  
G GROWTH & DIFFERENTIATION

SEXUAL DYSFUNCTION GENE LIST	HUGO symbol	Protein function
11beta hydroxysteroid dehydrogenase 2	HSD11B2	E
Acetylcholinesterase	ACHE	E
Activin		G
Adenylate cyclase 1	ADCY1	E
Adenylate cyclase 2	ADCY2	E
Adenylate cyclase 3	ADCY3	E
Adenylate cyclase 4	ADCY4	E
Adenylate cyclase 5	ADCY5	E
Adenylate cyclase 6	ADCY6	E
Adenylate cyclase 7	ADCY7	E
Adenylate cyclase 8	ADCY8	E
Adenylate cyclase 9	ADCY9	E
Adrenergic receptor, alpha1	ADRA1	N
Adrenergic receptor, alpha2	ADRA2	N
Adrenergic receptor, beta1	ADRB1	N
Adrenergic receptor, beta2	ADRB2	N
Adrenergic receptor, beta3	ADRB3	N
Adrenoleukodystrophy gene	ALD	E
alpha thalassemia gene	ATRX	N
Androgen binding protein	ABP	T
Angiopoietin 1	ANGPT1	G
Angiopoietin 2	ANGPT2	G
Angiotensin converting enzyme	ACE, DCP1	E

Angiotensin receptor 1	AGTR1	T
Angiotensin receptor 2	AGTR2	T
Angiotensinogen	AGT	E
Anti-Mullerian hormone	AMH	G
Anti-Mullerian hormone type 2 receptor	AMHR2	G
Arginase	ARG1	E
Arginine vasopressin	AVP	N
Arginine vasopressin receptor 1A	AVPR1A	N
Arginine vasopressin receptor 1B	AVPR1B	N
Arginine vasopressin receptor 2	AVPR2	N
Atrial natriuretic peptide	ANP	G
Atrial natriuretic peptide receptor A	NPR1	G
Atrial natriuretic peptide receptor B	NPR2	G
Atrial natriuretic peptide receptor C	NPR3	G
Autoimmune regulator, AIRE	AIRE	I
BCL2-associated X protein	BAX	G
Bloom syndrome protein	BLM	G
Calcium channel, voltage-dependent, alpha 1F subunit	CACNA1F	N
Calcium channel, voltage-dependent, Alpha-1B (CACNL1A5)	CACNA1B	N
Calcium channel, voltage-dependent, Alpha-1C	CACNA1C	N
Calcium channel, voltage-dependent, Alpha-1D	CACNA1D	N
Calcium channel, voltage-dependent, Alpha-1E (CACNL1A6)	CACNA1E	N
Calcium channel, voltage-dependent, Alpha-2/delta	CACNA2	N
Calcium channel, voltage-dependent, Beta 1	CACNB1	N
Calcium channel, voltage-dependent, Beta 3	CACNB3	N
Calcium channel, voltage-dependent, Neuronal, Gamma	CACNG2	N
Calcium channel, voltage-dependent, T-type		N
Carbonic anhydrase 3	CA3	E
Carbonic anhydrase 4	CA4	E
Carbonic anhydrase, alpha	CA1	E
Carbonic anhydrase, beta	CA2	E
Catechol-O-methyltransferase	COMT	E
Choline acetyltransferase	CHAT	E
Cyclic AMP response element modulator	CREM	G
Cyclic AMP-dependent protein kinase	PKA	E
Cyclic nucleotide phosphodiesterase 1B	PDE1B	E
Cyclic nucleotide phosphodiesterase 1B1	PDE1B1	E
Cyclic nucleotide phosphodiesterase 2A3	PDE2A3	E
Cyclic nucleotide phosphodiesterase 3A	PDE3A	E
Cyclic nucleotide phosphodiesterase 3B	PDE3B	E
Cyclic nucleotide phosphodiesterase 4A	PDE4A	E

Cyclic nucleotide phosphodiesterase 4C	PDE4C	E
Cyclic nucleotide phosphodiesterase 5A	PDE5A	E
Cyclic nucleotide phosphodiesterase 6A	PDE6A	E
Cyclic nucleotide phosphodiesterase 6B	PDE6B	E
Cyclic nucleotide phosphodiesterase 7	PDE7	E
Cyclic nucleotide phosphodiesterase 8	PDE8	E
Cyclic nucleotide phosphodiesterase 9A	PDE9A	E
Cyclooxygenase 1	COX1	E
Cyclooxygenase 2	COX2	E
CYP11A1	CYP11A1	E
CYP11B1	CYP11B1	E
CYP11B2	CYP11B2	E
CYP17	CYP17	E
CYP19	CYP19	E
CYP1A1	CYP1A1	E
CYP1A2	CYP1A2	E
CYP1B1	CYP1B1	E
CYP21	CYP21	E
CYP24	CYP24	E
CYP27	CYP27	E
CYP27B1	PDDR	E
CYP2A1	CYP2A1	E
CYP2A13	CYP2A13	E
CYP2A3	CYP2A3	E
CYP2A6V2	CYP2A6V2	E
CYP2A7	CYP2A7	E
CYP2B6	CYP2B6	E
CYP2C18	CYP2C18	E
CYP2C19	CYP2C19	E
CYP2C8	CYP2C8	E
CYP2C9	CYP2C9	E
CYP2D6	CYP2D6	E
CYP2E1	CYP2E1	E
CYP2F1	CYP2F1	E
CYP2J2	CYP2J2	E
CYP3A3	CYP3A3	E
CYP3A4	CYP3A4	E
CYP3A5	CYP3A5	E
CYP3A7	CYP3A7	E
CYP4A11	CYP4A11	E
CYP4B1	CYP4B1	E
CYP4F2	CYP4F2	E
CYP4F3	CYP4F3	E
CYP51	CYP51	E
CYP5A1	CYP5A1	E
CYP7A	CYP7A	E
CYP8	CYP8	E
Cystathionase	CTH	E

Cystathione beta synthase	CBS	E
Cytidine deaminase	CDA	E
Cytidine-5-prime-triphosphate synthetase	CTPS	E
Cytochrome a		E
Cytochrome c		E
Cytochrome c oxidase, MTCO		E
Cytokine-suppressive antiinflammatory drug-binding protein 1	CSBP1	I
Cytokine-suppressive antiinflammatory drug-binding protein 2	CSBP2	I
DAX1 nuclear receptor	DAX1	I
Deleted in azoospermia	DAZ	G
Diaphanous 2	DIAPH2	N
Disrupted meiotic cDNA 1, homolog	DMC1	G
Dopamine beta hydroxylase	DBH	E
Dopamine receptors D1	DRD1	N
Dopamine receptors D2	DRD2	N
Dopamine receptors D3	DRD3	N
Dopamine receptors D4	DRD4	N
Dopamine receptors D5	DRD5	N
Electron-transferring-flavoprotein alpha	ETFA	T
Electron-transferring-flavoprotein beta	ETFB	T
Electron-transferring flavoprotein dehydrogenase	ETFDH	E
Endometrial bleeding-associated factor	EBAF	G
Endothelin 1	EDN1	N
Endothelin 2	EDN2	N
Endothelin 3	EDN3	N
Endothelin converting enzyme	ECE1	N
Endothelin receptor type A	EDNRA	N
Endothelin receptor type B	EDNRB	N
Enolase	ENO1	E
Enoyl CoA isomerase		E
Enterokinase	PRSS7, ENTK	E
Epidermal growth factor	EGF	G
Epidermal growth factor receptor	EGFR	G
Facio-genital dysplasia	FGD1, FGDY	T
Factor XIII A & B	F13A & F13B	I
Fanconi anemia, complementation group A	FANCA	T
Fertilin protein	FTNB	G
Flightless-II, Drosophila homolog of	FLII	G
Folic acid receptor	FOLR	G
Glutathione	GSH	T
Glutathione S-transferase, GSTZ1	GSTZ1	E
Glyceraldehyde-3-phosphate dehydrogenase, GAPDH	GAPDH	E
Glycerol kinase	GK	E
Glycinamide ribonucleotide (GAR)	GART	E

transformylase		
Glycogen phosphorylase	PYGL	E
Gonadotropin releasing hormone	GNRH	G
Gonadotropin releasing hormone receptor	GNRHR	G
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 1, GNAI1	GNAI1	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 2, GNAI2	GNAI2	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 3, GNAI3	GNAI3	N
Hexosaminidase B	HEXB	E
Holoprosencephaly 1	HPE1	G
Holoprosencephaly 2	HPE2	G
Holoprosencephaly 3	HPE3	G
Holoprosencephaly 4	HPE4	G
Human placental lactogen	CSH1	G
Inhibin, alpha	INHA	G
Inhibin, beta A	INHBA	G
Inhibin, beta B	INHBB	G
Inhibin, beta C	INHBC	G
Insulin	INS	G
Insulin receptor	INSR	G
IP3 kinase		E
Kallman syndrome gene 1	KAL1	G
Laminin 5, alpha 3	LAMA3	G
Laminin 5, beta 3	LAMB3	G
Laminin receptor 1	LAMR1	G
Long QT-type 2 potassium channels	LQT2, KCNH2	T
Luteinizing hormone, beta chain	LHB	G
MAD (mothers against decapentaplegic, Drosophila) homologue 2	MADH2	G
Methylmalonyl-CoA mutase	MUT	E
Monoamine oxidase A	MAOA	E
Monoamine oxidase B	MAOB	E
Muscarinic receptor, M1	CHRM1	N
Muscarinic receptor, M2	CHRM2	N
Muscarinic receptor, M3	CHRM3	N
Muscarinic receptor, M4	CHRM4	N
Muscarinic receptor, M5	CHRM5	N
NADPH-dependent cytochrome P450 reductase	POR	E
Neuropeptide Y	NPY	N
Neuropeptide Y receptor Y1	NPY1R	N
Neuropeptide Y receptor Y2	NPY2R	N
Nitric oxide synthase 1, NOS1	NOS1	E
Nitric oxide synthase 2, NOS2	NOS2	E
Nitric oxide synthase 3, NOS3	NOS3	E
Oncogene ELK1	ELK1	G

Oncogene ELK2	ELK2	G
Paired box homeotic gene 3	PAX3	G
Patched (Drosophila) homolog, PTCH	PTCH	G
Potassium inwardly-rectifying channel J1	KCNJ1	N
Potassium inwardly-rectifying channel J11	KCNJ11	N
Potassium voltage-gated channel A1	KCNA1	N
Potassium voltage-gated channel E1	KCNE1	N
Potassium voltage-gated channel Q1	KCNQ1	N
Potassium voltage-gated channel Q2	KCNQ2	N
Potassium voltage-gated channel Q3	KCNQ3	N
Progesterone receptor (RU486 binding receptor)	PGR	G
Proopiomelanocortin	POMC	N
Prostasin, PRSS8	PRSS8	E
Ribosomal protein S4, X-linked	RPS4X	E
RIGUI	RIGUI	G
Serotonin receptor, 5HT1A	HTR1A	N
Serotonin receptor, 5HT1B	HTR1B	N
Serotonin receptor, 5HT1C	HTR1C	N
Serotonin receptor, 5HT1D	HTR1D	N
Serotonin receptor, 5HT1E	HTR1E	N
Serotonin receptor, 5HT1F	HTR1F	N
Serotonin receptor, 5HT2A	HTR2A	N
Serotonin receptor, 5HT2B	HTR2B	N
Serotonin receptor, 5HT2C	HTR2C	N
Serotonin receptor, 5HT3	HTR3	N
Serotonin receptor, 5HT4	HTR4	N
Serotonin receptor, 5HT5	HTR5	N
Serotonin receptor, 5HT6	HTR6	N
Serotonin receptor, 5HT7	HTR7	N
Sodium channel, non-voltage gated 1, alpha	SCNN1A	N
Sodium channel, non-voltage gated 1, beta	SCNN1B	N
Sodium channel, non-voltage gated 1, gamma	SCNN1G	N
Sodium channel, voltage gated, type V, alpha polypeptide	SCN5A	N
Sodium channel, voltage-gated, type 1, beta polypeptide	SCN1B	N
Solute carrier family 6 (GAMMA-AMINO BUTYRIC ACID transporter), member 1	SLC6A1	T
Solute carrier family 6 (neurotransmitter transporter, dopamine), member 3	SLC6A3	T
Solute carrier family 6 (neurotransmitter transporter, noradrenaline), member 2	SLC6A2	T
Sperm protamine P1	PRM1	G
Sperm protamine P2	PRM2	G
T-BOX 3	TBX3	G
Testis-specific protein Y	TSPY	G
Tyrosine hydroxylase	TH	E



UDP-glucuronosyltransferase 1	ugt1d, UGT1	E
UDP-glucuronosyltransferase 2	UGT2	E
Vasoactive intestinal polypeptide	VIP	N
Vasoactive intestinal polypeptide receptor	VIPR	N
Zona pellucida glycoprotein 1	ZP1	G
Zona pellucida glycoprotein 2	ZP2	G
Zona pellucida glycoprotein 3	ZP3	G
Zona pellucida receptor tyrosine kinase	ZRK	G
Zonadhesin	ZAN	G

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## CLAIMS

1. A set of nucleotide probes for detecting relevant variants (mutations and polymorphisms), e.g. nucleotide substitutions (missense, nonsense, splicing and regulatory), small deletions, small insertions, small insertion deletions, gross insertions, gross deletions, duplications, complex rearrangements and repeat variations in a target group of genes which relate to adverse events; said probes being complementary to DNA and RNA sequences of said group of genes; characterised in that said group is a core group of genes consisting of substantially all of the following:

### KEY TO 'PROTEIN FUNCTION' COLUMN

E ENZYME  
 T TRANSPORT & STORAGE  
 S STRUCTURAL  
 I IMMUNITY  
 N NERVOUS TRANSMISSION  
 G GROWTH & DIFFERENTIATION

### ADME GENE LIST

ADME GENE LIST	HUGO gene symbol	Protein function
5-adenosyl homocysteine hydrolase		E
Acetoacetyl 1-CoA-thiolase	ACAT1	E
Acetoacetyl 2-CoA-thiolase	ACAT2	E
Acetyl CoA acyltransferase	ACAA	E
Acetylcholine receptor, nicotinic, alpha A1	CHRNA1	N
Acetylcholine receptor, nicotinic, alpha A2	CHRNA2	N
Acetylcholine receptor, nicotinic, alpha A3	CHRNA3	N
Acetylcholine receptor, nicotinic, alpha A4	CHRNA4	N
Acetylcholine receptor, nicotinic, alpha A5	CHRNA5	N
Acetylcholine receptor, nicotinic, alpha A6	CHRNA6	N
Acetylcholine receptor, nicotinic, alpha A7	CHRNA7	N
Acetylcholine receptor, nicotinic, beta 1	CHRNA1	N
Acetylcholine receptor, nicotinic, beta 2	CHRNA2	N
Acetylcholine receptor, nicotinic, beta 3	CHRNA3	N
Acetylcholine receptor, nicotinic, beta 4	CHRNA4	N
Acetylcholine receptor, nicotinic, epsilon	CHRNA5	N
Acetylcholine receptor, nicotinic, gamma	CHRNA6	N
Acetylcholinesterase	ACHE	E
Actin, alpha, cardiac	ACTC	S
Actin, alpha, skeletal	ACTA1	S
Actin, alpha, smooth, aortic	ACTA2	S
Actin, beta	ACTB	S
Actin, gamma 2	ACTG2	S
Acyl CoA dehydrogenase, short chain	ACADS	E

Adenine phosphoribosyltransferase	APRT	T
Adenosine deaminase	ADA	E
Adenosine monophosphate deaminase	AMPD	E
Adenosine receptor A1	ADORA1	N
Adenosine receptor A2A	ADORA2A	N
Adenosine receptor A2B	ADORA2B	N
Adenosine receptor A3	ADORA3	N
Adenylate cyclase 1	ADCY1	E
Adenylate cyclase 2	ADCY2	E
Adenylate cyclase 3	ADCY3	E
Adenylate cyclase 4	ADCY4	E
Adenylate cyclase 5	ADCY5	E
Adenylate cyclase 6	ADCY6	E
Adenylate cyclase 7	ADCY7	E
Adenylate cyclase 8	ADCY8	E
Adenylate cyclase 9	ADCY9	E
Adenylate kinase	AK1	E
Adenylate transferase		E
Adenylosuccinate lyase	ADSL	E
ADP-ribosyltransferase	ADPRT	E
Adrenergic receptor, alpha1	ADRA1	N
Adrenergic receptor, alpha2	ADRA2	N
Adrenergic receptor, beta1	ADRB1	N
Adrenergic receptor, beta2	ADRB2	N
Adrenergic receptor, beta3	ADRB3	N
Adrenocorticotrophic hormone (ACTH) receptor	ACTHR	G
Adrenoleukodystrophy gene	ALD	E
Albumin, ALB	ALB	T
Alkaptonuria gene	AKU	G
Alpha 1 acid glycoprotein	AAG; AGP	T
alpha1-antitrypsin	PI	E
alpha2-antiplasmin	PLI	E
alpha-amylase		E
Alpha-fetoprotein	AFP	G
alpha-glucosidase, neutral AB	GANAB	E
alpha-glucosidase, neutral C	GANC	E
Aminomethyltransferase	AMT	E
Aminopeptidase P	XPNPEP2	E
Amyloid beta (A4) precursor protein-binding, APBB1	APBB1	N
Amyloid beta A4 precursor protein	APP	N
Androgen binding protein	ABP	T
Androgen receptor	AR	G
Angiotensin converting enzyme	ACE, DCP1	E
Angiotensin receptor 1	AGTR1	T
Angiotensin receptor 2	AGTR2	T
Angiotensinogen	AGT	E

Annexin 1	ANX 1	I
Apurinic endonuclease	APE	E
Arginine vasopressin	AVP	N
Arginine vasopressin receptor 1A	AVPR1A	N
Arginine vasopressin receptor 1B	AVPR1B	N
Arginine vasopressin receptor 2	AVPR2	N
Aryl hydrocarbon receptor	AHR	T
Arylsulfatase E	ARSE	E
Aspartate transcarbamoylase		E
Ataxia telangiectasia gene, AT	ATM	G
ATP cobalamin adenosyltransferase		E
ATP sulphurylase	atpsk2	E
ATP/ADP translocase		E
Atrial natriuretic peptide	ANP	G
Atrial natriuretic peptide receptor A	NPR1	G
Atrial natriuretic peptide receptor B	NPR2	G
Atrial natriuretic peptide receptor C	NPR3	G
BCL2-associated X protein	BAX	G
Benzodiazepine receptor		N
beta-endorphin receptor		N
Bile acid coenzyme A: amino acid N-acyltransferase	BAAT	E
Bile salt export pump	BSEP, PFIC2	T
Bile salt-stimulated lipase	CEL	E
Bilirubin UDP-glucuronosyltransferase		E
Biliverdin reductase		T
Bleomycin hydrolase	BLMH	E
Bradykinin receptor B1		I
Bradykinin receptor B2		I
Breakpoint cluster region	BCR	G
Breast cancer 1	BRCA1	G
Breast cancer 2	BRCA2	G
Brush border guanylyl cyclase		E
Butyrylcholinesterase	BCHE	E
Ca(2+) transporting ATPase, fast twitch	ATP2A1	T
Ca(2+) transporting ATPase, slow twitch	ATP2A2	T
Calcineurin A1	CALNA1	I
Calcineurin A2	CALNA2	I
Calcineurin A3	CALNA3	I
Calcineurin B		I
Calcitonin receptor /Calcitonin gene-related peptide receptor	CALCR	N
Calcium channel, voltage-dependent, alpha 1F subunit	CACNA1F	N
Calcium channel, voltage-dependent, Alpha-1B (CACNL1A5)	CACNA1B	N
Calcium channel, voltage-dependent, Alpha-1C	CACNA1C	N



Calcium channel, voltage-dependent, Alpha-1D	CACNA1D	N
Calcium channel, voltage-dependent, Alpha-1E (CACNL1A6)	CACNA1E	N
Calcium channel, voltage-dependent, Alpha-2/delta	CACNA2	N
Calcium channel, voltage-dependent, Beta 1	CACNB1	N
Calcium channel, voltage-dependent, Beta 3	CACNB3	N
Calcium channel, voltage-dependent, L type, alpha 1S subunit	CACNA1S	N
Calcium channel, voltage-dependent, Neuronal, Gamma	CACNG2	N
Calcium channel, voltage-dependent, P/Q type, alpha 1A subunit	CACNA1A	N
Calcium channel, voltage-dependent, T-type		N
Canalicular multispecific organic anion transporter	CMOAT	T
Cannabinoid receptor	CNR1	N
Carbamoylphosphate synthetase 1	CPS1	E
Carbamoylphosphate synthetase 2	CPS2	E
Carbonic anhydrase 3	CA3	E
Carbonic anhydrase 4	CA4	E
Carbonic anhydrase, alpha	CA1	E
Carbonic anhydrase, beta	CA2	E
Carnitine transporter protein	CDSP, SCD	T
Carnosinase		N
Cartilage-hair hypoplasia gene	CHH	N
Catalase	CAT	I
Catechol-O-methyltransferase	COMT	E
Catenin, beta	CTNNB1	G
Cell adhesion molecule, vascular, VCAM	VCAM1	G
Cholecystokinin	CCK	N
Cholecystokinin B receptor	CCKBR	N
Cholesterol ester transfer protein	CETP	T
Choline acetyltransferase	CHAT	E
CoA transferase		E
Colony-stimulating factor 1	CSF1	G
Colony-stimulating factor 2	CSF2	G
Colony-stimulating factor 3	CSF3	G
Colony-stimulating factor 3 receptor	CSF3R	G
Complex V	MTATP6	E
Coproporphyrinogen oxidase	CPO	E
Cortico-steroid binding protein		T
Corticosteroid nuclear receptor		I
Corticotrophin-releasing hormone receptor	CRHR1	T
Creb binding protein	CREBBP	G
Crystallin, alpha A	CRYAA	S
Crystallin, alpha B	CRYAB	S

Crystallin, beta B2	CRYBB2	S
Crystallin, gamma A	CRYGA	S
Cu <sup>2+</sup> transporting ATPase alpha polypeptide	ATP7A	E
Cu <sup>2+</sup> transporting ATPase beta polypeptide	ATP7B	E
Cyclic AMP response element binding protein	CREB	G
Cyclic AMP response element modulator	CREM	G
Cyclic AMP-dependent protein kinase	PKA	E
Cyclic nucleotide phosphodiesterase 1B	PDE1B	E
Cyclic nucleotide phosphodiesterase 1B1	PDE1B1	E
Cyclic nucleotide phosphodiesterase 2A3	PDE2A3	E
Cyclic nucleotide phosphodiesterase 3A	PDE3A	E
Cyclic nucleotide phosphodiesterase 3B	PDE3B	E
Cyclic nucleotide phosphodiesterase 4A	PDE4A	E
Cyclic nucleotide phosphodiesterase 4C	PDE4C	E
Cyclic nucleotide phosphodiesterase 5A	PDE5A	E
Cyclic nucleotide phosphodiesterase 6A	PDE6A	E
Cyclic nucleotide phosphodiesterase 6B	PDE6B	E
Cyclic nucleotide phosphodiesterase 7	PDE7	E
Cyclic nucleotide phosphodiesterase 8	PDE8	E
Cyclic nucleotide phosphodiesterase 9A	PDE9A	E
Cyclin F	CCNF	G
Cyclin-dependent kinase inhibitor 1A (P21, CIP1)	CDKN1A	G
Cyclooxygenase 1	COX1	E
Cyclooxygenase 2	COX2	E
Cyclophilin		I
CYP11A1	CYP11A1	E
CYP11B1	CYP11B1	E
CYP11B2	CYP11B2	E
CYP17	CYP17	E
CYP19	CYP19	E
CYP1A1	CYP1A1	E
CYP1A2	CYP1A2	E
CYP1B1	CYP1B1	E
CYP21	CYP21	E
CYP24	CYP24	E
CYP27	CYP27	E
CYP27B1	PDDR	E
CYP2A1	CYP2A1	E
CYP2A13	CYP2A13	E
CYP2A3	CYP2A3	E
CYP2A6V2	CYP2A6V2	E
CYP2A7	CYP2A7	E
CYP2B6	CYP2B6	E
CYP2C18	CYP2C18	E
CYP2C19	CYP2C19	E
CYP2C8	CYP2C8	E
CYP2C9	CYP2C9	E

CYP2D6	CYP2D6	E
CYP2E1	CYP2E1	E
CYP2F1	CYP2F1	E
CYP2J2	CYP2J2	E
CYP3A3	CYP3A3	E
CYP3A4	CYP3A4	E
CYP3A5	CYP3A5	E
CYP3A7	CYP3A7	E
CYP4A11	CYP4A11	E
CYP4B1	CYP4B1	E
CYP4F2	CYP4F2	E
CYP4F3	CYP4F3	E
CYP51	CYP51	E
CYP5A1	CYP5A1	E
CYP7A	CYP7A	E
CYP8	CYP8	E
Cystic fibrosis transmembrane conductance regulator, CFTR	CFTR	N
Cytidine deaminase	CDA	E
Cytidine-5-prime-triphosphate synthetase	CTPS	E
Cytokine-suppressive antiinflammatory drug- binding protein 1	CSBP1	I
Cytokine-suppressive antiinflammatory drug- binding protein 2	CSBP2	I
Deoxycytidine kinase DCK		E
Deoxyuridine triphosphatase; dUTPase		E
DHEA sulfotransferase	STD	E
Dihydrodiol dehydrogenase 1	DDH1	E
Dihydrofolate reductase	DHFR	E
Dihydrolipoamide branched chain transacylase	DBT	N
Dihydrolipoamide dehydrogenase	DLD	N
Dihydrolipoyl dehydrogenase 2	PDHA	E
Dihydrolipoyl transacetylase	PDHA	E
Dihydroorotase		E
Dihydropyrimidine dehydrogenase	DPYD	E
Disrupted meiotic cDNA 1, homolog	DMC1	G
DNA damage binding protein, DDB1	DDB1	S
DNA damage binding protein, DDB2	DDB2	S
DNA directed polymerase, alpha	POLA	E
DNA glycosylases		E
DNA helicases		E
DNA Ligase 1	LIG1	E
DNA methyltransferase	DNMT	E
DNA polymerase 1		E
DNA polymerase 2		E
DNA polymerase 3		E
DNA primase		E
DNA-damage-inducible transcript 3	DDIT3	S

DNA-dependant RNA polymerase		E
Dopamine receptors D1	DRD1	N
Dopamine receptors D2	DRD2	N
Dopamine receptors D3	DRD3	N
Dopamine receptors D4	DRD4	N
Dopamine receptors D5	DRD5	N
Erythropoietin	EPO	I
Erythropoietin receptor	EPOR	I
Estrogen receptor	ESR	G
Excision repair complementation group 1 protein	ERCC1	E
Excision repair complementation group 2 protein	ERCC2	E
Excision repair complementation group 2 protein	ERCC3	E
Excision repair complementation group 4 protein	ERCC4	E
Excision repair complementation group 6 protein	ERCC6	E
Factor H	HF1	I
Factor IX	F9	I
Factor VII	F7	I
Factor VIII	F8	I
Factor X	F10	I
Fatty acid binding proteins FABP1		T
Fatty acid binding proteins FABP2	FABP2	T
Fatty acid binding proteins FABP3		T
Fatty acid binding proteins FABP4		T
Fatty acid binding proteins FABP5		T
Fatty acid binding proteins FABP6		T
Fibroblast growth factor	FGF1	G
Flavin-containing monooxygenase 1	FMO1	E
Flavin-containing monooxygenase 2	FMO2	E
Flavin-containing monooxygenase 3	FMO3	E
Flavin-containing monooxygenase 4	FMO4	E
Folic acid receptor	FOLR	G
Follicle stimulating hormone receptor	FSHR, ODG1	G
Follicle stimulating hormone, FSH	FSHB	G
Forkhead transcription factor 10	FKHL10	G
Forkhead transcription factor 14	FKHL14	G
Forkhead transcription factor 7	FKHL7	G
G/T mismatch binding protein	GTBP, MSH6	G
GABA receptor, alpha 1	GABRA1	N
GABA receptor, alpha 2	GABRA2	N
GABA receptor, alpha 3	GABRA3	N
GABA receptor, alpha 4	GABRA4	N
GABA receptor, alpha 5	GABRA5	N
GABA receptor, alpha 6	GABRA6	N

GABA receptor, beta 1	GABRB1	N
GABA receptor, beta 2	GABRB2	N
GABA receptor, beta 3	GABRB3	N
GABA receptor, gamma 1	GABRG1	N
GABA receptor, gamma 2	GABRG2	N
GABA receptor, gamma 3	GABRG3	N
GABA transaminase	ABAT	E
Gadd45 (growth arrest & DNA-damage-inducible protein)		E
Galactose 1-phosphate uridyl-transferase	GALT	E
Gamma-glutamyl carboxylase	GGCX	T
Gamma-glutamyltransferase 1	GGT1	T
Gamma-glutamyltransferase 2	GGT2	T
Gastric inhibitory polypeptide receptor, GIPR	GIPR	T
Gastric lipase, LIPF		T
Glucagon receptor	GCGR	G
Glucocorticoid receptor	GRL	G
Glucosaminyl (N-acetyl) transferase 2, I-branching enzyme	GCNT2	E
Glucosidase, acid beta	GBA	E
Glutamate decarboxylase, GAD	GAD1	E
Glutamate receptor 1	GLUR1	N
Glutamate receptor 2	GLUR2	N
Glutamate receptor 3	GLUR3	N
Glutamate receptor 4	GLUR4	N
Glutamate receptor 5	GLUR5	N
Glutamate receptor 6	GLUR6	N
Glutamate receptor 7	GLUR7	N
Glutamate receptor, ionotropic, NMDA 1	NMDAR1	N
Glutamate receptor, ionotropic, NMDA 2A	NMDAR2A	N
Glutamate receptor, ionotropic, NMDA 2B	NMDAR2B	N
Glutamate receptor, ionotropic, NMDA 2C	NMDAR2C	N
Glutamate receptor, ionotropic, NMDA 2D	NMDAR2D	N
Glutamine phosphoribosylpyrophosphate amidotransferase/PRPP amidotransferase		E
Glutathione	GSH	T
Glutathione peroxidase, GPX1	GPX1	E
Glutathione peroxidase, GPX2	GPX2	E
Glutathione reductase, GSR	GSR	E
Glutathione S-transferase mu 1, GSTM1	GSTM1	E
Glutathione S-transferase mu 4, GSTM4		E
Glutathione S-transferase theta 1, GSTT1	GSTT1	E
Glutathione S-transferase theta 2, GSTT2		E
Glutathione S-transferase, GSTP1	GSTP1	E
Glutathione S-transferase, GSTZ1	GSTZ1	E
Glutathione synthetase	GSS	E
Glyceraldehyde-3-phosphate dehydrogenase, GAPDH	GAPDH	E
Glycinamide ribonucleotide (GAR)	GART	E

transformylase		
Glycine receptor, alpha	GLRA2	N
Glycine receptor, beta		N
Glycine transporter	GLYT	N
Gonadotropin releasing hormone	GNRH	G
Gonadotropin releasing hormone receptor	GNRHR	G
Growth arrest-specific homeobox	GAX	G
Growth hormone 1	GH1	G
Growth hormone 2 (placental)	GH2	G
Growth hormone receptor	GHR	G
Growth hormone releasing hormone (GHRH)	GHRH	G
Growth hormone releasing hormone receptor	GHRHR	G
GTP cylcohydrolase 1	GCH1	G
GTPase-activating protein, GAP	RASA1	G
Guanidinoacetate N-methyltransferase	GAMT	E
Guanine nucleotide-binding protein, alpha activating activity polypeptide, GNAO	GNAO1	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 1, GNAI1	GNAI1	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 2, GNAI2	GNAI2	N
Guanine nucleotide-binding protein, alpha inhibiting activity polypeptide 3, GNAI3	GNAI3	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS1	GNAS1	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS2	GNAS2	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS3	GNAS3	N
Guanine nucleotide-binding protein, alpha stimulating activity polypeptide, GNAS4	GNAS4	N
Guanine nucleotide-binding protein, alpha transducing activity polypeptide, GNAT1	GNAT1	N
Guanine nucleotide-binding protein, alpha transducing activity polypeptide, GNAT2	GNAT2	N
Guanine nucleotide-binding protein, beta polypeptide 3	GNB3	N
Guanine nucleotide-binding protein, gamma polypeptide 5	GNG5	N
Guanine nucleotide-binding protein, q polypeptide	GNAQ	N
Guanylate cyclase 2D, membrane (retina- specific)	GUCY2D	E
Guanylate cyclase activator 1A (retina)	GUCA1A	E
Guanylate kinase		E
Guanylin	GUCA2	T
Guanylyl cyclase		E
H(+), K(+) - ATPase	ATP4B	N

Heat shock protein, HSP60		I
Heat shock protein, HSP70		I
Heat shock protein, HSP90		I
Hemopexin	HPX	I
Hepatic lipase	LIPC	E
Histamine receptors, H1		N
Histamine receptors, H2		N
Histamine receptors, H3		N
HLH transcription factor HAND1	HAND1	G
HLH transcription factor HAND2	HAND2	G
HMG-CoA lyase	HMGCL	E
HMG-CoA reductase	HMGCR	E
HMG-CoA synthase	HMGCS2	E
Hormone-sensitive lipase	HSL	E
HSSB, replication protein		E
Hypoxanthine-guanine phosphoribosyltransferase, HGPRT	HPRT	E
Ibonucleoside diphosphate reductase		E
Ikaros gene	IKAROS	G
Inosine monophosphate dehydrogenase, IMPDH		E
Inosine triphosphatase	ITPA	E
Inositol monophosphatase	IMPA1	N
Insulin	INS	G
Insulin receptor	INSR	G
Insulin-like growth factor 1 receptor	IGF1R	G
Insulin-like growth factor 2 receptor	IGF2R	G
Interferon alpha	IFNA1	I
Interferon beta	IFNB	I
Interferon gamma	IFNG	I
Interferon gamma receptor 1	IFNGR1	I
Interferon gamma receptor 2	IFNGR2	I
Interferon regulatory factor 1	IRF1	I
Interferon regulatory factor 4	IRF4	I
Interleukin(IL) 1 receptor	IL1R	I
Interleukin(IL) 1, alpha	IL1A	I
Interleukin(IL) 1, beta	IL1B	I
Interleukin(IL) 10	IL10	I
Interleukin(IL) 10 receptor	IL10R	I
Interleukin(IL) 11	IL11	I
Interleukin(IL) 11 receptor	IL11R	I
Interleukin(IL) 12	IL12	I
Interleukin(IL) 12 receptor, beta 1	IL12RB1	I
Interleukin(IL) 13	IL13	I
Interleukin(IL) 13 receptor	IL13R	I
Interleukin(IL) 2	IL2	I
Interleukin(IL) 2 receptor, alpha	IL2RA	I
Interleukin(IL) 2 receptor, gamma	IL2RG	I